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MA

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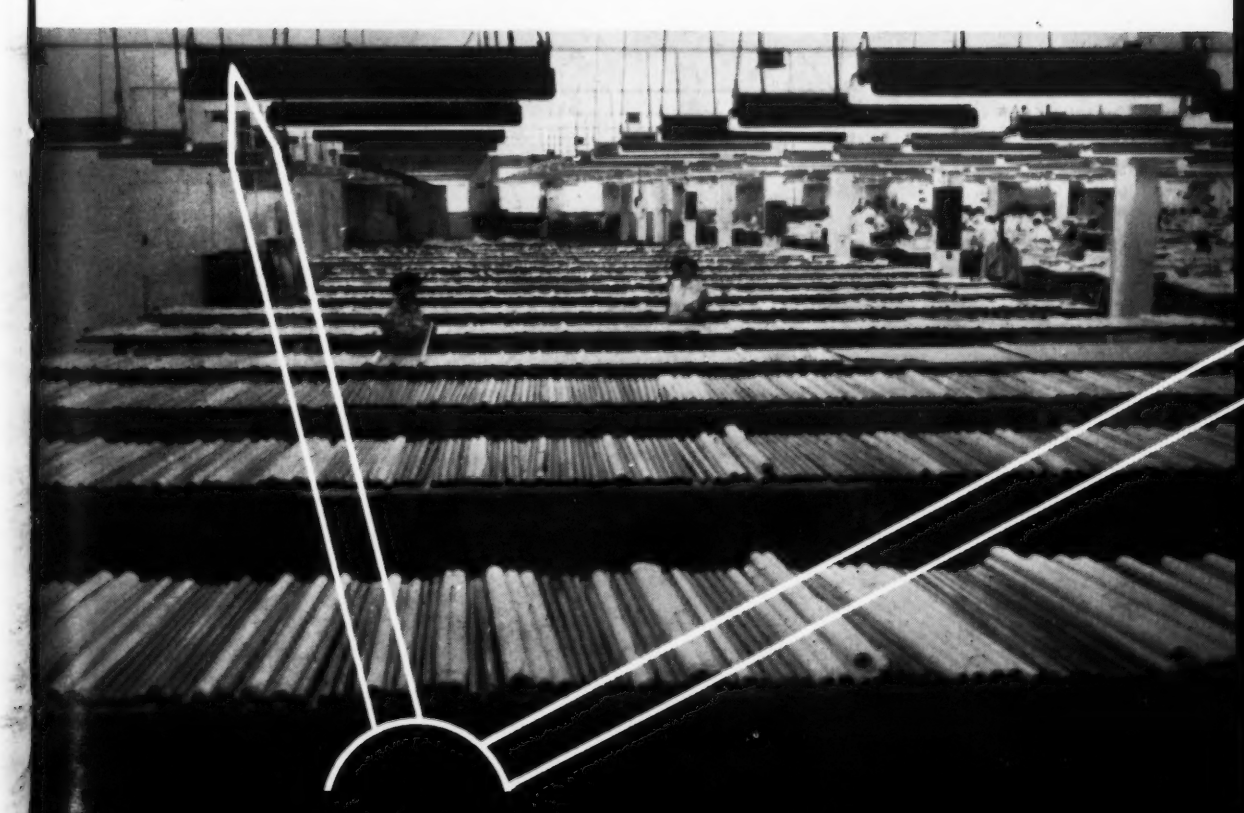

to microfilm

Automatic methods applied to microfilmed drawings save manpower, space and money
.....Page 194

ALSO—Air Traffic Display Tubes, Servos, Printed Circuits, Digital Techniques, and New at WESCON

IN THIS ISSUE . . .

. . . we take pleasure in previewing the Western Electronic Show and Convention (WESCON) being held at the Cow Palace, San Francisco, August 20-23, 1957, by a special "New at Wescon" section (page 224).

The *use of devices for performing automatic decisions and efforts** is exemplified in the "Engineering Drawings for the Armed Forces" (page 194). This article shows how fiscal and manpower economies are being achieved in one specialized field through the joint efforts of the Armed Forces and industry.

Our May-June article on the "Charactron" shaped beam display tube has inspired a survey article (page 206) on the working principles of a number of other air-traffic and memory display devices now in production or under development.

Other articles include (1) number 2 in our series on servos with a basic mathematical analysis of a simple servo system, (2) "Printed Circuitry" chapter 4, Components, and (3) a pictorial listing of the units which comprise the large digital computers produced by International Business Machines Corporation.

Featurettes point up the importance of laboratory test methods in "Floating Test Lab," "Lint-free Lab Helps Wheels Spin," and "White Noise." An ingenuous method of correcting radar scope images for map making also is discussed (Radar Restitutor). The recent address by Mr. Ross Nichols, vice-president of Weston Electrical Instrument Co., appraising government contracts from the viewpoint of the contractor is reported on our editorial page.

A pioneer in the field of simulation, Mr. Ed Link is the subject of our Biobit this issue. He is, incidentally, still making simulator history.

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* Automation—the use of devices (electrical, electronic, mechanical, pneumatic and hydraulic) for performing automatic decisions and efforts—*M. H. Aronson*

MA "Subscriptions"

Military Automation is mailed without charge to the business address of qualified applicants who follow the instructions provided on page 182. No mailings will be made outside the United States, except to military post office numbers.

Subscribers, either military or civilian, who are transferred to new billets should notify us giving both their old and new addresses. If your successor in your present billet wishes to receive MA he should make a separate application for a subscription. If you change employers, you will be sent a regular qualification sheet, to be completed for your new position.

MA military automation

VOL. 1, NO. 4

JULY-AUGUST 1957

Editorial

Feature Articles

Featurettes

Regular Features

Bill Erickson discusses MAGNETIC TAPE RECORDING

Most phenomena that can be depicted electrically can be recorded on magnetic tape. Long-known but relatively recently perfected, magnetic tape recording has won wide acceptance as a particularly valuable tool in data-handling and process control applications. The very nature and versatility of this tool, however, require the most mature judgment in its use, lest unwarranted enthusiasm lead to misapplications and incorrect results.

In the field of industrial control, magnetic tape recording has been used most effectively for the storage of electrical analog information in such processes as conveyor control for article sorting, machine tool and pattern control, dry and liquid food batch mixing, and so forth. In data-handling problems, it has served the engineer in speeding analyses of complex physical phenomena. In communications experiments, multi-channel tape units have provided the scientist with simulation of otherwise physically unrealizeable filters. In all these instances, the merit of magnetic tape recording lies in its ability to store electrical analog information and make it available for play-back, or re-run, as often as may be necessary.

Of the few methods available to "advance" or "retard" time, none is as practical as the use of magnetic tape. For instance, it is frequently overlooked that a tape recording can be considered as a variable delay line of considerable equivalent electrical length. Merely by varying the play-back speed, or the relative position of the reproduce heads, or both, one line (or tape) can be used to delay a number of signals relative to each other, one signal relative to a number of others, or to some external source.

Despite this versatility there are definite limits of usefulness within which the application of tape recording should be confined. Such a limit is typified in the problem of signal "dropout." By this is meant the distortion, or even complete loss, of a signal caused by the presence of minute nodules in the tape itself. The occurrence of such imperfections is completely random and can be controlled only during production of the tape. And while significant progress has been made in recent years to improve the quality of tape, ultimate perfection has not yet been achieved.

In data-handling and process control fields, the use of magnetic tape recording is particularly well-suited to digital techniques where large quantities of information can be stored most economically in a minimum amount of space. In all applications where high-speed random access

Wilbur Erickson, systems engineer, specializing in input-output equipment, discusses magnetic tape recording.

is not required, magnetic tape recording provides a relatively inexpensive and wholly suitable solution to the recurring information storage problem. Here signal dropout is virtually eliminated because the electrical impulses are of a pulse present-pulse omission presentation and are recorded at, or very near, the tape saturation level.

The use of magnetic tape recording is, at one and the same time, the prerogative and the responsibility of the systems engineer. His experience and ability to make intelligent use of this one of the many tools available to him, will define his stature as a systems man. The potential of magnetic tape recording in systems has barely been scratched, but the applications to which it can, and undoubtedly will, be put are as limitless as man's imagination to devise them.

MA military automation

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MA Letters

Editor, MA:

Your first issue of *MILITARY AUTOMATION* was excellent; I waited for the next issues to see if they would be on the same level to warrant an expression of my cold judgement and feelings. Congratulations! Your articles are excellent. Very best wishes for your continued success. I was particularly interested in Analog Computation and Modern Digital Computers.

V. Dunbar
Sperry Gyroscope Co.

Editor, MA:

I have forwarded the copies of MA to our Engineer-in-Chief, Rear Admiral K. K. Cowart. I am sure he will be greatly interested in them. Best wishes for the success of *MILITARY AUTOMATION.*

E. T. Calahan
Captain, USCG
Chief, Public Information Division
United States Coast Guard

Editor, MA:

Thank you for the luncheon and introduction to your new publication *MILITARY AUTOMATION* at the Sheraton Park Hotel. I have thought over your proposed objectives and find them more and more admirable.

Benton H. Schaub
Office of the Assistant Secretary of Defense for Engineering.

Editor, MA:

I want to thank you for the subscription to your magazine. The articles are well written and informative. Unfortunately the magazine has one bad feature: It is difficult to clip and file the articles. This is especially true when two articles are on opposite side of the same page.

Would it be possible to receive reprints of any of articles?

Martin Abel
Electro Data Div.
Burroughs Corporation

As you may notice, we are experimenting with some changes in our article format which may make it easier for you "clippers" to operate. This we will do by separating major articles by short features which are less likely to be saved; and, when possible, by dispersing advertisements through articles so that clippings will fit better in 8" x 10" folders. We are sorry that reprints on articles are not available in most cases; and that the first two issues have been exhausted.

Letters—*Continued*

Editor, MA:

Your publication is very impressive. An associate here at Lockheed has allowed me to read his copies, and I have found them so interesting and informative that I would like to ask to be placed on your mailing list. I was particularly impressed with the articles on Analog and Digital computers. I am an instructor of electronics in the Field Service Department here where we train military personnel.

John M. Reynolds
Lockheed Aircraft Corp.

Mr. Reynolds has received and returned our MA subscriber verification form and is now a "Qualified Subscriber".

Editor, MA:

I have just received my March-April issue of *MILITARY AUTOMATION* . . . If there is a copy of the first issue available, I would appreciate receiving one.

This is an excellent magazine and it will be well used in our Engineering Division.

Jack Adams
Training Officer
San Francisco Naval Shipyard

Thanks very much for your kind appraisal of MA, Mr. Adams. However, in answer to the many requests for back issues which we continue to receive, printings of the first and second issue are now exhausted; consequently requests for these issues cannot be satisfied.

Editor, MA:

Would it be possible to receive at this time a complete copy of your serialized articles entitled "Printed Circuitry" written by Allan Lytel?

Walter Raines
Sperry Gyroscopic Co.

We expect to publish this series in book form within the next four months; which will precede the termination of the article series in MA by several months.

Editor, MA:

It is very difficult to criticize an article that obviously took a great deal of time and effort to prepare. However, the article on "Modern Digital Techniques" in the May-June 1957 issue certainly merits some constructive comments.

There are three specific points which I wish to note. The first pertains to the statement that (large) memory capacity and (fast) access time are mutually incompatible. This statement is easily disproved. Magnetic core memories with capacities measured in 100,000's of bits and microseconds of access times are available today in the IBM 704 and 705 and the Univac II. A more correct statement would have related memory capacity and access time to cost. As yet, no manufacturer has succeeded in producing large capacity memories with fast access times for a *low* cost. It is the cost factor that is most responsible for the prevalence of slower access but large capacity drum memories in the small and intermediate digital computers of today.

The second point to note is the inclusion of the Potter RAM and the Clevite Tape DRUM as the latest developments of quasi-random access to memory devices. Both are several years old and neither has been used with any commercially available computer system. The authors should have noted the IBM RAMAC unit with a 5 million character random-access memory capacity and the Burroughs Datafile with a 20 million, quasi-random access memory capacity.

This brings me to the third point. The list of computer characteristics (Table 9) has omitted two very significant machines. These are the IBM RAMAC 305 and the Remington Rand Univac File Computer. Both machines are commercially available and have been ordered in large quantities. In addition, the IBM RAMAC 305 represents a significant departure from present machine organizations. This fact alone merits its inclusion in any article on "modern" digital techniques.

J. Svigals
San Jose, Calif.

Your points are well presented and your courtesy in writing is appreciated. We hope to bring our treatment of these points up-to-date in our revision of this series which will appear in book form this fall. The 305 is discussed in this issue on page 222. The author's comments follow:

As to the incompatability of fast and large memories, cost is a limitation, but not the basic limitation. Large memories require large selection circuits. Large selection circuitry means large series inductance and/or large distributed capacitance. This is the basic limitation. As for details on recent models, it is difficult to get accurate information from the manufacturers, aside from brief publicity releases, until design details are finalized.

Martin A. Klein

Editor, M-A:

The 2-way helmet radio pictured in Fig. 7, page 136 of your May-June issue of Military Automation, appears to have considerable potential commercially in large chemical plants, especially since safety helmets are almost universally used.

Any information that you could supply me regarding a means for procuring these or similar 2-way helmet radios would be greatly appreciated.

C. A. Pfretzschner
Instrumentation Engineer
Union Carbide Chemicals Co.

The transistorized helmet radio units were developed by the Army Signal Corps Engineering Laboratories at Fort Monmouth, N. J. We suggest that a letter addressed to the Director of this activity will bring you the information you desire.

MA

August 20-23

Western Electronic Show and Convention, Cow Palace, San Francisco, Calif. (See page 224)

August 26-30

Eighth Annual Infrared Spectroscopy Institute, Fisk University, Nashville 8, Tenn. For information write Nelson Fulson, Infrared Spectroscopy Institute, Fisk University, Nashville, Tenn.

September 4-6

Second Technical Conference and Exhibit on Magnetic Amplifiers, Penn Sheraton, Pittsburgh, Pa. For information write David Feldman, Bell Telephone Labs., Whippany, N. J.

October 3-4

Tenth Annual Quartermaster Association Convention, San Francisco, Calif. For more information write, Col. A. L. Bivens, president, Northern California Chapter, Q.A., P. O. Box 105, Presidio of San Francisco, Calif.

October 7-9

National Electronics Conference, Sherman Hotel, Chicago, Ill. For information write J. S. Powers, Executive Secretary, National Electronics Conference, 84 E. Randolph St., Chicago 1, Ill.

October 24-25

Fourteenth Annual Display of Aviation Electrical Equipment, Pan Pacific Auditorium, Los Angeles. For information write Mr. Howard Ryerson, care of Lynn-Western, Inc., 6901 Melrose Ave., Los Angeles 38, Calif.

November 5-6

Joint Military Industry Guided Missile Reliability Symposium, Naval Air Missile Test Center, Pt. Mugu, Calif. Persons desiring to attend must have a Secret security clearance and should make known their plans by August 15 to Commander, USNAMTC, Reliability Symposium, Code CEN-1, U. S. Naval Air Missile Test Center, Point Mugu, Calif.

December 6-7

American Rocket Society, Eastern Regional Student Conference, Hotel Statler, New York, N. Y. For information write Mr. Mario W. Cardullo, Pres., Polytechnic Chapter, ARS, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 1, N. Y.

June 9-13, 1958

Fourth International Automation Congress & Exposition and First Military Automation Exposition, Coliseum, New York, N. Y. For information write to Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

MA Editorial

Ross Nichols of Weston speaks to SAMA Convention

Government Contracts As Seen By The Contractor

ROSS NICHOLS, Vice President of Weston Electrical Instrument Co., shown above in his May 1st address before the 39th Annual Meeting of the Scientific Apparatus Makers Association in Hot Sulphur Springs, W. Va., gave needed illumination on some problems associated with government contracting. Government military purchases ($20 billion) are important because of their volume. This figure is greater than the combined sales of General Motors, General Electric, Standard Oil, and U. S. Steel. The health and state of readiness of the defense industry is directly affected by government procurement practices.

He stated that, from the contractor's standpoint, many difficulties arise out of the basic fact that government is, at the same time, both a customer and a sovereign state. As a customer, it would be concerned with price only, but as sovereign it makes the procurement contract a vehicle for attaining social objectives. The customer cares little where the plant is located or its size; but as a sovereign it distinguishes between "big" and "little" business, and between concerns in areas with different ratios of employment to the employables, etc.

He explained that three types of contracts being utilized by Government procurement officers are; (1) cost-reimbursement plus fee, (2) negotiated fixed-price and (3) advertised, with sealed bids. Although stating that a return to the time-honored practice of purchase through sealed bids on specifications in response to advertised invitations would solve many present problems, he said that in the case of newly developed items, or in cases where security measures are involved, the first two methods also have their place.

The cost-reimbursement-plus-fee contract drew the most criticism. This system imposes upon the contractor a series of limitations designed for the protection of the Government and then exposes him to the critical review of the Government audit section. Unallowable items of cost, according to the Armed Services Procurement Regulations (ASPR), include: Bad debts, contingency reserve, entertainment cost, excess facility cost, fines and penalties, interest and other financial costs, losses on other contracts, organization costs, pre-contract costs, reconversion costs and profit of loss on disposition of plant, equipment or other capital assets. He pointed out that all the above are actual costs to any contractor and that many are allowable business deductions for Federal Income Tax. Also, if a certificate of necessity has been secured, the contractor can use the accelerated amortization for tax purposes but not for pricing purposes. Mr. Nichols said that items specifically not allowed were not as great a hazard as other items originally allowed but later questioned by the audit section—perhaps after completion of the contract—when the contractor learns that his price is considerably less than planned.

The fixed-price contract is presumed to mean the agreed price remains fixed after initial estimation of costs. However, since no definite ASPR section has been designed for fixed-price contracts, some procurement officers apply cost-type or terminated-contract rules to this type of contract. More appropriate rules are needed. Above all, contractors should insist on writing-in those details which have been agreed on. Also be certain that details of government contracts are thoroughly understood before signing.

The amount of profit and the base on which it should be computed is another undefined area. Pinched between labor's drive to raise wages and the procurement regulations, industry is moving rapidly toward more automatic production causing a rapid rate of plant obsolescence. Renegotiation was defined as the "third guess". First you make a deal, then you have "redetermination". Then, after that is worked out you have "renegotiation". This tends to limit the profits of the efficient manufacturer to the level of the inefficient.

Mr. Nichols concluded by saying that the SAMA

should join with other manufacturing organizations in working with government procurement offices to improve the contract situation because only through such efforts will conditions improve. He reiterated his belief that all such efforts can be only partially effective due to the Government's dual personality, but that there is the continuing necessity to impress upon the procurement agencies the need for profits available for plough-back so that industry will be capable of performing adequately in any emergency.

"The Unavoidable Shelter Race"

This caption is the title of a letter by the Radiological Defense Coordinator of the Multnomah (Oregon) Civil Defense Agency in a recent issue of the *Bulletin of the Atomic Scientists*. He states that after a careful study of a complete transcript of testimony before the Hollifield Committee, he has concluded that competition between the United States and Russia in the building of adequate shelters is an inevitable evolution of the present H-bomb—ballistic race. As a stalemate in offensive weapons is reached, the defensive aspects assume greater relative importance. He warns that if this conclusion is true, the longer such a construction program is delayed, the more urgent, poorly-planned, and wasteful it will eventually prove. He quotes testimony offered in the hearings that Russia has already made considerable headway in providing shelters around her cities and in dispersing her vital industry.

Providing shelter is only one small part of any "shelter race", as we see it. We must also decentralize our military supply so that duplicate or parallel plants, warehouses, power plants, and essential records will be maintained. If we intelligently utilize the many techniques of automation which have been developed in the last decade, we can accurately control dispersed machine tools, reproduce data records, and telemeter instrument readings for the protection of the operating personnel of those operations which cannot be temporarily suspended during periods of attack. The same techniques can be used to enable the rapid transfer of production to new centers after a disaster or to maintain coordination between parallel facilities. Also emergency power, radiac equipment, communications, automatically controlled bull-dozers and rescue vehicles will be needed if, as, and when our stalled Civil Defense program gets off dead center.

It also appears that if the casualty predictions based on recent Civil Defense practice alerts are even approximate, and if some bombers or missiles can penetrate the best air defense, as the Department of Defense warns us, then it is time for the President to propose and for Congress to enact legislation that will encourage the construction of shelters and the dispersion of industry to ensure our "staying power" in any nuclear conflict.

MA Bio-Bits

The purpose of these short biographical sketches is to provide our readers with an insight into the lives of some of the military and scientific leaders now guiding the development of automation for the U. S. Armed Forces. This month we are happy to introduce Mr. Edwin A. Link, Director, General Precision Equipment; Chairman of the Board, Link Aviation, Inc.

Ed Link

Every now and then, and with increasing frequency, one sees a news item announcing a purchase by the Air Force of a "flight simulator" for one of its jet aircraft—or perhaps the item announces the Navy has ordered a quantity of "operational flight trainers" for a supersonic fighter plane.

Each time such an announcement is made, another tribute to the inventive genius of Edwin A. Link is logged into the aviation history books.

The business of building "simulators," which today is a highly-competitive, multi-million-dollar industry serving both military and commercial aviation, has grown from a seed planted by Ed Link just 28 years ago—a seed that didn't take root and start to grow until almost six years later.

It was in 1929 that young Ed Link of Binghamton, New York, built his first pilot trainer—a mechanical device resembling a large, toy airplane. Purpose of his trainer was to provide a safe and economic means, on the ground, for pilots to learn the techniques and procedures of flying.

Ed's original "Pilot Maker" consisted of a stubby wooden fuselage with cockpit, mounted on an organ

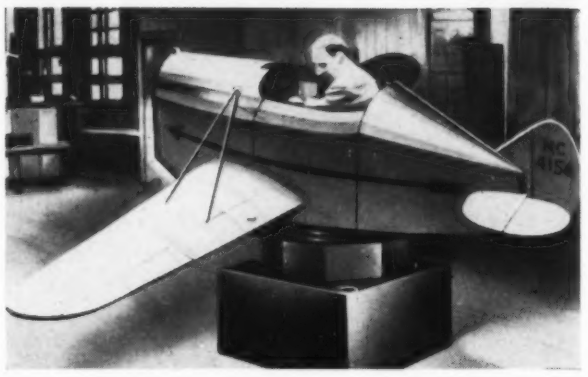


FIG. 1. ED LINK FLYING the first Link Trainer, used about 1929 as part of a learn-to-fly package for would-be pilots.

bellows which he had "borrowed" from his father's piano factory (Fig. 1). The bellows was operated by an electrically-driven vacuum pump, which caused the fuselage to pitch and roll as the pilot "flew" the trainer.

The cockpit was equipped with standard aircraft controls; later, after a few modifications, it also was provided with what few instruments were in general use during that period.

Ed and some of his closest friends were convinced that his trainer was a practical and useful device. It was not until 1934, however, that Ed's invention and pilot training theories began to catch on.

Ed's big break came in 1934. With the help of a friend—World War I pilot Charles S. (Casey) Jones—he succeeded in getting a group of Air Corps officers together for a demonstration of the trainer.

The demonstration was scheduled for Newark, New Jersey, but the day Ed was supposed to fly in from Binghamton turned out to be very foggy and misty. The Air Corps group arrived at the airport, took one look at the soupy weather, and concluded that Ed Link would not arrive.

But just as they were about to leave, Ed's plane droned overhead. He made it on instruments—a rare feat during those early days of aviation—and his accomplishment convinced the Air Corps that he knew plenty about instrument flight.

The rest was easy. Ed demonstrated the trainer and soon received an order for six units. Other orders followed, and the company's growth was assured.

During World War II, Ed's young company really came into its own; turned out trainers at the rate of one every 45 minutes. With a peak payroll of 1,500 employees, the company turned out "blue boxes" that were used to train more than a half million airmen throughout the world.

Contracts were obtained for a huge navigational trainer, special radio aids, submarine docking trainers and flexible gunnery trainers.

And the company built its now famous C-11, the first jet trainer ever produced and, later, the B-47B, the world's first jet bomber simulator.

By this time, the mechanical-type trainers had

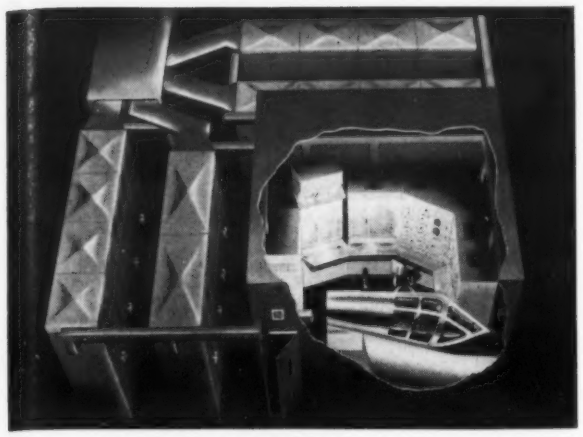


FIG. 2. ARTIST'S RENDERING of the simulator for the supersonic, delta-winged F-102A interceptor. Flight records are in background and operator's controls and duplicate instruments against right wall. At left and rear of the training area are the steel cabinets which house the electronic computers, electro-mechanical components and air conditioning units.

been replaced by complex electro-mechanical analog computers to insure that each flight simulator "flew" —instrument-wise—exactly like its airborne counterpart.

Each simulator was equipped with the latest simulated radio aids and navigation equipment; the instructor's area was equipped with automatic graphic flight recorders, duplicate cockpit instruments, and facilities for introducing a number of hazardous emergency flight conditions and mechanical malfunctions.

In 1953 Ed Link named E. Allan Williford as the company's second president, and Ed moved up to become chairman of the board. Another step taken by Ed Link was to affiliate his company with the General Precision Equipment Corporation in 1954.

Today, with a record employment of 2,600, Link is building complex electronic flight simulators for such aircraft as the Air Force's F-102 (Fig. 2) and F-106 and the Navy's F11F and F8U. Link also is producing for the Air Force a unique simulator for training guidance crews of the Martin Matador pilotless bomber.

In addition, the company also leads the simulator industry in number of orders received for commercial jet and prop-jet simulators. With simulators for such forthcoming airliners as the Douglas DC-8, Boeing 707, Lockheed Electra and Convair 880 already in the works, Link lists as its customers such airlines as United, Eastern, National, KLM, SAS, Qantas and TWA.

For his many contributions to aviation, Ed has received the Potts Medal, the Wakefield Gold Medal, and the Exceptional Service Award.

He co-authored *Simplified Celestial Navigation* with Capt. P. V. H. Weems, USN.

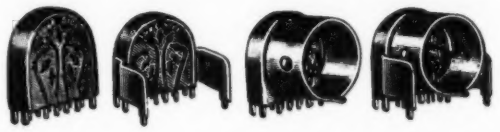
Ed married Marion Clayton at Ilion, N. Y., in 1932. Their two sons are: William Martin Link, born January 1, 1938, and Edwin Clayton Link, born November 30, 1941.

M/A Lit Bits

Excerpts from important manufacturers' literature

Right-Angle Tube Sockets

New sockets for printed-circuit assembly: (1) Save space to permit compact packaging allowing tubes to be placed closer to heat sinks, (2) increase shock resistance as lower position of tube mass reduces strain on socket caused by acceleration, (3) mount easily; are ideally suited for hand or mechanized insertion into printed wiring boards, (4) are

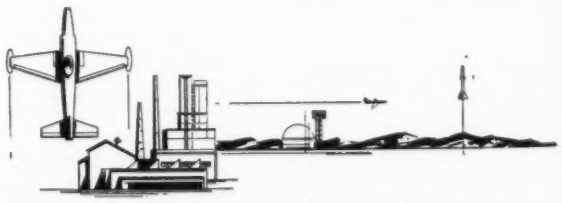


versatile as long terminals permit use of right-angle tube sockets on a wide range of board thicknesses, (5) are plated to meet specifications of salt spray test. Sockets meet existing ML specifications. Silver-Plated contacts assure minimum contact resistance. (*"From new Materials and Specification" Bulletin, Pacific Coast Div., Aerovox Corporation,* 2724 *S. Peck Rd., Monrovia, Calif.*)

For this literature circle **101** on inquiry card.

Fire Detection

All the components of the fire and overheat detection system, the accessory overheat indicating and alarm system and the systems themselves—products of the instrument division—are found in more than 12,000 military and civil aircraft. Fire and overheat



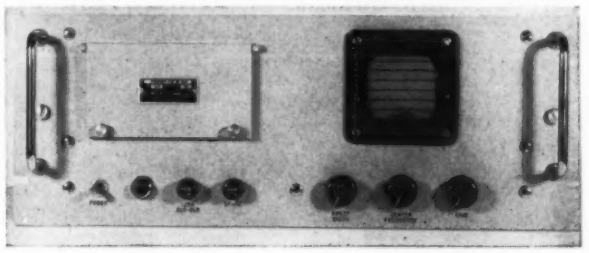
detection with the new continuous cable fire detector is another Edison first. The semiconductor type cable is unusually flexible, is extremely sensitive to heat and is virtually immune to fire or mechanical damage. It detects fire at any point along its length. Approved for military and civil aircraft under latest applicable specifications. *From new 16-page bulletin also including resistance temperature detectors, hermetically sealed time-delay relays and sensitive magnetic relays, Thomas A. Edison Industries, West Orange, N. J.*

For this literature circle **102** on inquiry card.

Lit-Bits—*Continued*

Spectrum Display Units

The purpose of a Spectrum Display Unit is to provide a visual indication of the signal to which a receiver is tuned, as well as to provide a visual indication of signals in a band of frequencies above and



below that being received. The signals are displayed on a cathode-ray tube that has a calibrated screen allowing both frequency and relative amplitude of received signals to be determined.

The frequency band being displayed is adjustable by means of a sweep width control. Maximum sweep width is normally used to search for other signals around the desired frequency. Reduced sweep width is used when evaluating the signal being received and the type of modulation used can be determined. (*From new 2-page bulletin, Nems-Clarke, Inc., Silver Springs, Md.*)

For this literature circle **103** on inquiry card.

Phase Sensitive Demodulator

The Hoover Model 10019 Phase Sensitive Demodulator, with its associated 400-cycle power supply, is a compact, lightweight unit which serves as the link between a guidance system and a telemetering

INPUT	OUTPUT		
400-cycle signal	0 to 5 VDC*	or	−2.5 VDC to +2.5 VDC**
Zero	+2.5 VDC ±0.025 VDC		0 to ±0.025 VDC
Full-scale in phase with ref	+5 VDC ±0.025 VDC		+2.5 VDC ±0.025 VDC
Full-scale 180° out of phase with ref.	0 to ±0.025 VDC		−2.5 VDC ±0.025 VDC

*Linear function of input
**Proportional to input

system. It supplies subcarrier oscillators with signals proportional to the position of three gyros, synchros or other position sensing devices. In addition, it supplies a signal representing the a-c reference voltage in the system.

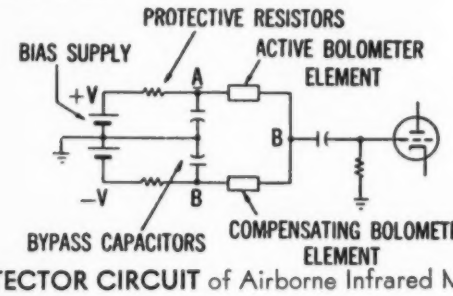
The Model 10019 and its associated power supply provide for four channels, three of which are phase sensitive demodulators and the other is an a-c rectification channel. Minimum input impedance on all phase sensitive channels is one megohm. Input impedance on the reference channel is 100K. (*From new 4-page bulletin, Hoover Electronics Co., 3640 Woodland Ave., Baltimore 15, Md.*)

For this literature circle **104** on inquiry card.

Lit-Bits— *Continued*

Monochromator Sees Infrared

A complete radiation laboratory in itself, the AIM is designed: (To determine the absolute spectral distribution of radiation from airborne targets in the 1.5-25-micron region (A micron is equal to 1 x 10^{-6} meter); (2) to determine the total radiation from targets; (3) to record these measurements on a two-channel recorder.



DETECTOR CIRCUIT of Airborne Infrared Monochromator

On the AIM, a visual and an IR optical system are joined by a parallelogram linkage that is gyroscopically stabilized in yaw and pitch. When an operator sights the target, he simultaneously brings the IR optical system to bear on it.

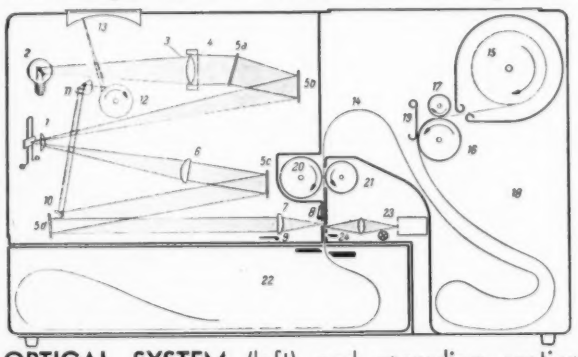
Target radiations gathered by the IR optical system are focused on the entrance slit of the monochromator and measured with respect to a known reference level —a hot body whose temperature is electronically controlled.

Both total and dispersed radiation are measured—each by a separate thermistor bolometer. (*From new* 8-*page Bulletin* 1256, *Servo Corp. of America,* 20-20 *Jericho Turnpike, New Hyde Park, N. Y.*

For this literature circle **105** on inquiry card.

Oscilloport

The Oscilloport is a multi-purpose instrument which records electrical oscillations versus time in true relation to amplitude and reveals their interdependence



OPTICAL SYSTEM (left) and recording section (right).

by simultaneously tracing four phenomena. As the equipment is dust and rain proof, designed for 24 v dc, and built to take the strains of transport, it can be used in the field. (*From new* 6-*page Bulletin SH-*3348, *Seimens—New York, Inc.,* 350 *Fifth Ave., New York* 1, *N. Y.*)

For this literature circle **106** on inquiry card.

Giant observation window reveals one of the "supercontrolled" areas in the new half-million dollar Reeves Instrument gyroscope laboratory where white-robed technicians develop and assemble miniature HIGs (hermetic integrating gyroscopes) produced to tolerances as close as 0.00001 inch.

Lint Free Lab Helps Wheels Spin

GYROS are the heart of inertial guidance systems because they provide the stabilization reference for navigation beyond the earth's surface. Some gyros weigh less than four ounces, measure one inch in diameter, yet have drift rates in navigation less than three degrees per hour. Their two-hundred parts must be precision machined and assembled to microscopic tolerances.

In order to provide facilities for such fine work, a new half-million dollar research and production facility has just been completed by Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America, at its Roosevelt Field plant. It is already in production on the newest types of floated gyroscopes with friction torque level less than 0.0000015 ounce-inch, and accelerometers with production tolerances as close as 0.00001 inch. Gyros made here include 1, 2 and 3½″ dia integrating gyros, 1 and 2″ rate gyros, 2″ pendulous integrating gyros, etc. Progress has been made towards development of even smaller and more accurate models of these instruments.

The laboratory for prototype gyro research uses an air filtration system that catches particles of dust as small as 3/10 micron (0.000012 inch). The effectiveness of the filtration system and the size of the particles filtered out can be judged by the fact that one average puff of cigarette smoke contains 12 billion particles, with each particle averaging 6/10 micron —twice the size of those trapped in the "supercontrolled" laboratory zone. All waste is removed through vacuum hoses built into the walls and all material entering the laboratory is electronically cleaned and passes through a "push through" which turns so that its opening can be in only one room at a time. Humidity and temperature are continuously monitored and recorded.

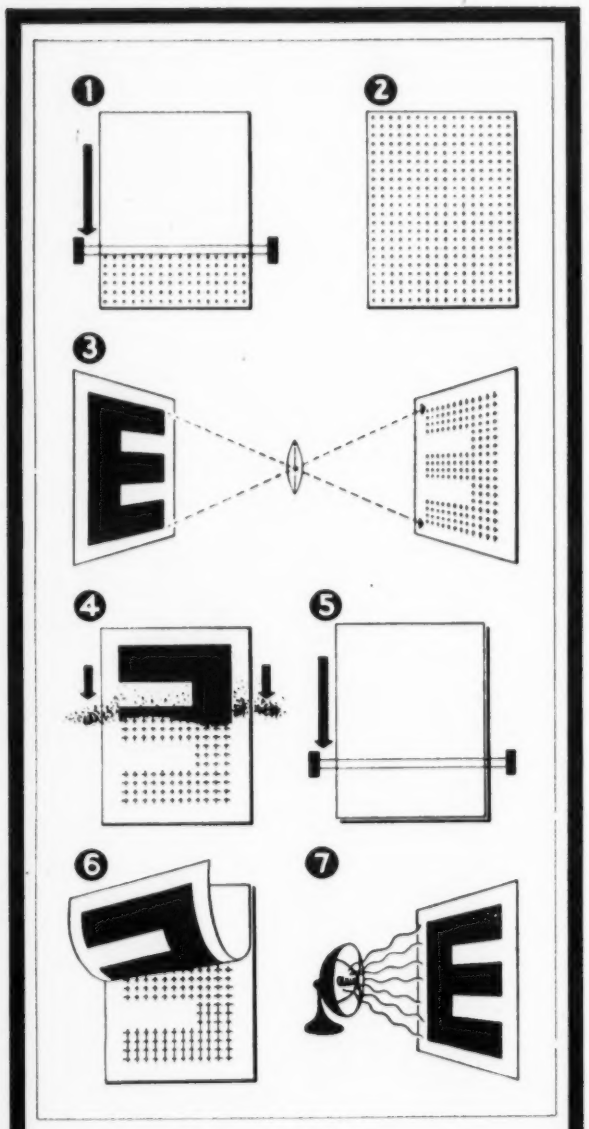
Engineering and development rooms surrounding the laboratory include two gyro sub-assembly rooms, a model shop and an electro-magnetics section. These areas house electronic gages calibrated to 0.000001 inch and are termed "moderately dust controlled"—the filtration system eliminates particles of dust larger than 5 microns (0.0002 inch). Here engineers and technicians work out new mass-production techniques and develop components for new prototypes.

A general production and sub-assembly area where gyros, once out of prototype stage, are started in mass production also is "moderately dust controlled" (5 micron filtration). From this section the miniature gyros go to the final assembly area, which, like the laboratory, is "supercontrolled" (3/10 micron filtration) because the final stage is the most delicate of all in manufacture.

The gyros are used in long-range missiles to provide error signal if missile drifts from pre-set course. These signals (from two to seven such gyros and accelerometers) are evaluated by a computer which commands corrective devices.

For information on Reeves Hermetic Integrating Gyroscopes circle **201** on inquiry card.

Problems associated with the management of millions of engineering drawings include (1) filing, (2) storage, (3) reproduction, (4) mailing, (5) quick reference and (6) up-dating. Here are some modern automatic approaches to these problems by the Armed Forces.



How Xerography Works

1. Selenium-coated plate is electrostatically charged by passing under wires. 2. Coating of plate is charged positively. 3. Copy (E) is projected through lens in camera. Charge remains only in areas protected by shade as light discharges exposed areas. 4. Plastic powder (developer) adheres to charged areas. 5. Sheet of plain paper is placed over developed plate and electrified positively to attract powder off plate to paper. 6. Paper is removed; powder forms a direct (re-reversed) image on paper. 7. Print is heated for a few seconds to fuse powder into permanent print. Offset master may be used instead of paper.

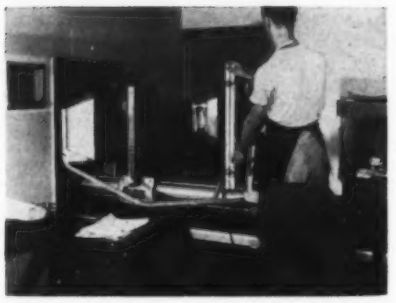


FIG. 2. OPERATOR PUTS ORIGINAL drawing in holder; decides exposure time and sets lens diaphragm. Aide in darkroom exposes positively-charged, selenium-coated XeroX plate for prescribed period. (Photo courtesy Haloid Co.)

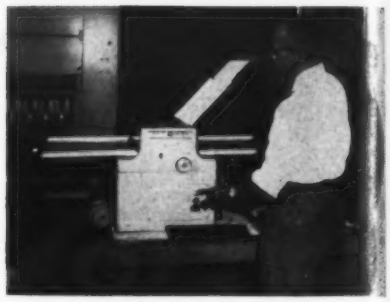


FIG. 3. DEVELOPED IMAGE ON EXPOSED XeroX plate being transferred to offset paper master. This equipment charges paper master positively to attract negatively charged powder from plate. (Photo to courtesy Haloid Co.)

ENGINEERING DRAWINGS FOR TH

THE ARMED FORCES annually create, distribute, file and consult millions of engineering drawings incidental to procurement of items for national defense. For example, the Signal Corps includes drawings with its invitations for bids by subcontractors, and issues many more for reference by field engineers and installation personnel. Naval aircraft annually require 250,000 master drawings, 750,000 Van Dyke prints, and 3 million blueprint copies. The Air Force has an engineering drawing requirement of even greater magnitude. Other offices in each service and in other government departments are likewise confronted by the formidable problem of engineering drawing management.

Different procurement offices, in seeking solutions for their own problems, have evolved different answers, some of which may suggest suitable applications of rapid duplicating services to other activities. This article illustrates applications of the XeroX®* Filmsort®** and Recordak®*** equipment to some needs of the three services.

The Signal Supply Agency Application of Xerography

The Army Signal Supply Agency in Philadelphia is concerned chiefly with supplying print copies to prospective bidders. Drawings are either 8″ x 10″ or 11″ x 17″ and many copies of each are needed.

Xerography is used to make paper offset masters to be used on standard duplicating machines that can print over 5000 copies per hour. The basic process is shown in Fig. 1. At the ASSA, the original drawings are copied with a xerographic camera (Fig. 2) onto an 11″ x 17″ electrically-charged selenium plate. This plate is then dusted with a powdered plastic, which is then electrostatically transferred to a paper offset master (Fig. 3) and fused into permanent form (Fig. 4). The remainder of the process is standard offset duplication (Fig. 5) of as many copies as the mailing requires. Savings are made in the speed with which offset masters are produced from a wide range of drawing sizes, standardization of mailing in 12″ x 18″ envelopes, elimination of print trimming, lower cost of print copies, and reduction of mailing charges.

The Signal Supply Agency estimates that it now saves more than a half-million dollars annually by the use of xerography and offset duplication as against mailing blueprints. Recently, when the Agency sought bids for its MPQ-10 mortar locator radar, it solicited 65 companies. Each mailing contained 1,973 drawings. Under the old method of blueprint reproduction it would have required 250 manhours and cost $6,040. By the new method only 107 manhours were required at a cost of $2,180.

Air Force and Other Applications

Xerography is used also at numerous installations of the Air Force. At Wright Patterson alone there are some 21 XeroX installations ranging from the standard office type to the more elaborate Model 1218

*XeroX is a trademark copyrighted by The Haloid Co., Rochester, N. Y.

**Filmsort is a copyright of the Dexter Folder Company, Pearl River, N. Y.

***Recordak is a trademark of Recordak Corp., New York 22 N. Y.

FIG. 4. POWDER IMAGE ON OFFSET PAPER master is made permanent by baking. Foregoing steps have taken about three minutes. Master is now ready for duplicator. (Photo courtesy Haloid Co.)

FIG. 5. MASTER IS MOUNTED ON OFFSET duplicator which runs off as many copies as required by U.S. Army Signal Corps. (Photo courtesy Haloid Co.)

FIG. 6. VAN DYKE PRINTS FROM which blueprints are made cannot be folded. Roll storage, shipping, handling is a space- and labor-consuming operation at Naval ASO, Philadelphia. (Official U.S. Navy Photograph)

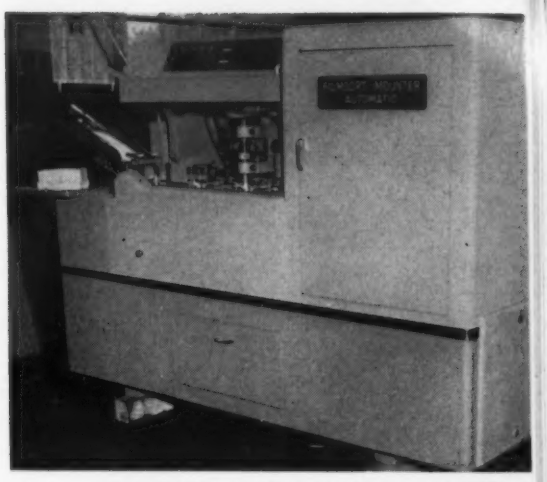


FIG. 7. FILMSORT AUTOMATIC MOUNTER takes deck of punched EAM (Electronic Accounting Machine) cards and roll microfilm, automatically mounts film in aperture cards and punches them to agree with master. (Official U. S. Navy Photograph)

THE ARMED FORCES

similar to the equipment used by the Signal Supply Agency in Philadelphia.

At the Warrenton, Va., Air Force Training Center, an 11″ XeroX Copyflo®* continuous printer automatically turns out training information copies 11″ wide from roll microfilm at the rate of 20′/min. The 11″ Copyflo has the following models: One copies from roll microfilm; another, called an opaque-head type, copies from original documents as large as 24″ wide; a third combines the input capabilities of the first two. All models can print at the rate of 20′/min.

The 11″ Copyflo printer also is used at the Armed Forces Technical Information Agency, Dayton, Ohio, where it has turned out more than a million feet of copy since last Fall. This agency, operated by the ARDC, Air Force, for all three services, is a clearing house of scientific and technical information in support of the Research and Development program of the Department of Defense. It collects, indexes, abstracts, and stores scientific and technical reports covering the results of the DOD R&D effort.

The Naval Air Prototype Program

The Naval Aviation Supply Office (ASO) in Philadelphia, cooperating with other interested DOD offices and with the technical assistance of the Haloid Company and the Dexter Folder Company, has developed a prototype Xerographic-Filmsort system which further reduces handwork, storage space and shipping costs. The Filmsort system uses easily-re-

*Copyflo is a trademark copyrighted by The Haloid Co., Rochester, N. Y.

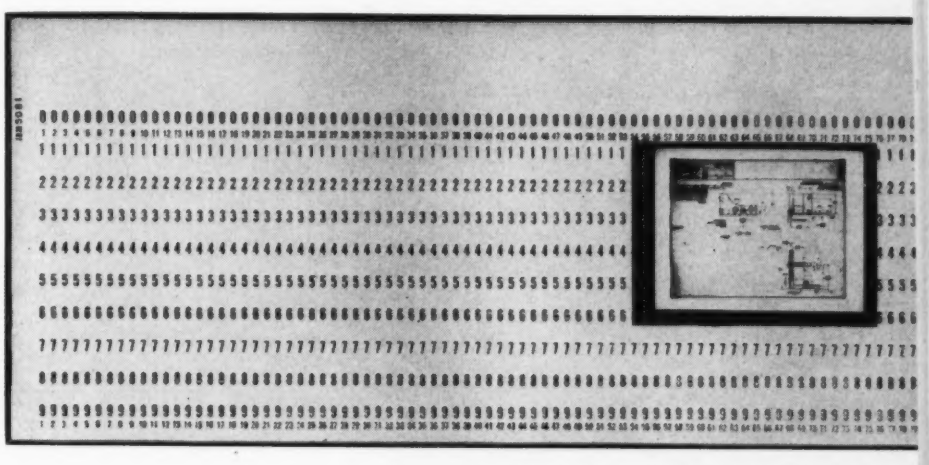


FIG. 8. FILMSORT APERTURE CARD has small aperture for 35-mm film positive. Punched and typed data can be entered on card on the 50 lines to the left of the aperture. (Photo courtesy Haloid Co.)

FIG. 9. FILMSORT AUTOMATIC CARD-TO-CARD printer reproduces duplicate Filmsort cards from mounted film by dry, rapid process. Input cards are blank cards loaded with blank film in aperture. Output cards have developed film and punched data. (Official U.S. Navy Photograph)

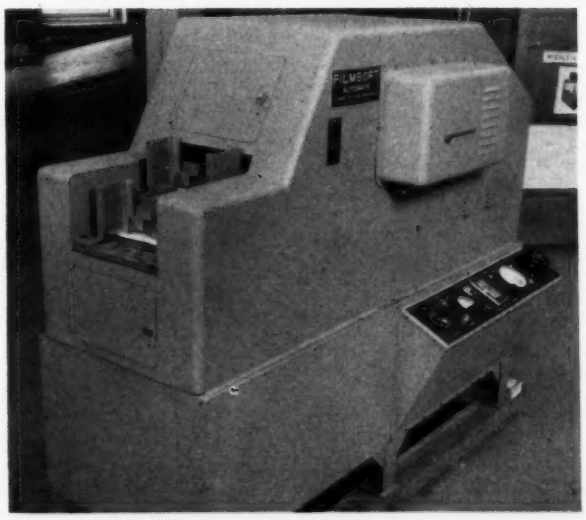
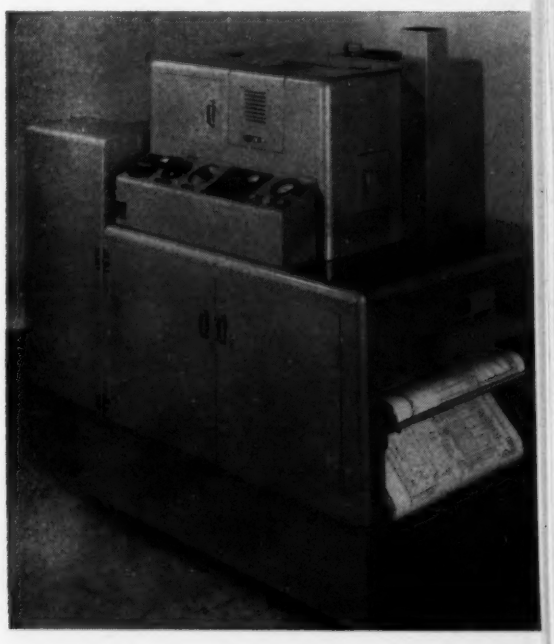


FIG. 10. XEROX COPYFLO CONTINUOUS PRINTER turns out 24″-wide engineering drawings at rate of 20′/min from Filmsort tabulating cards. (Photo courtesy Haloid Co.)



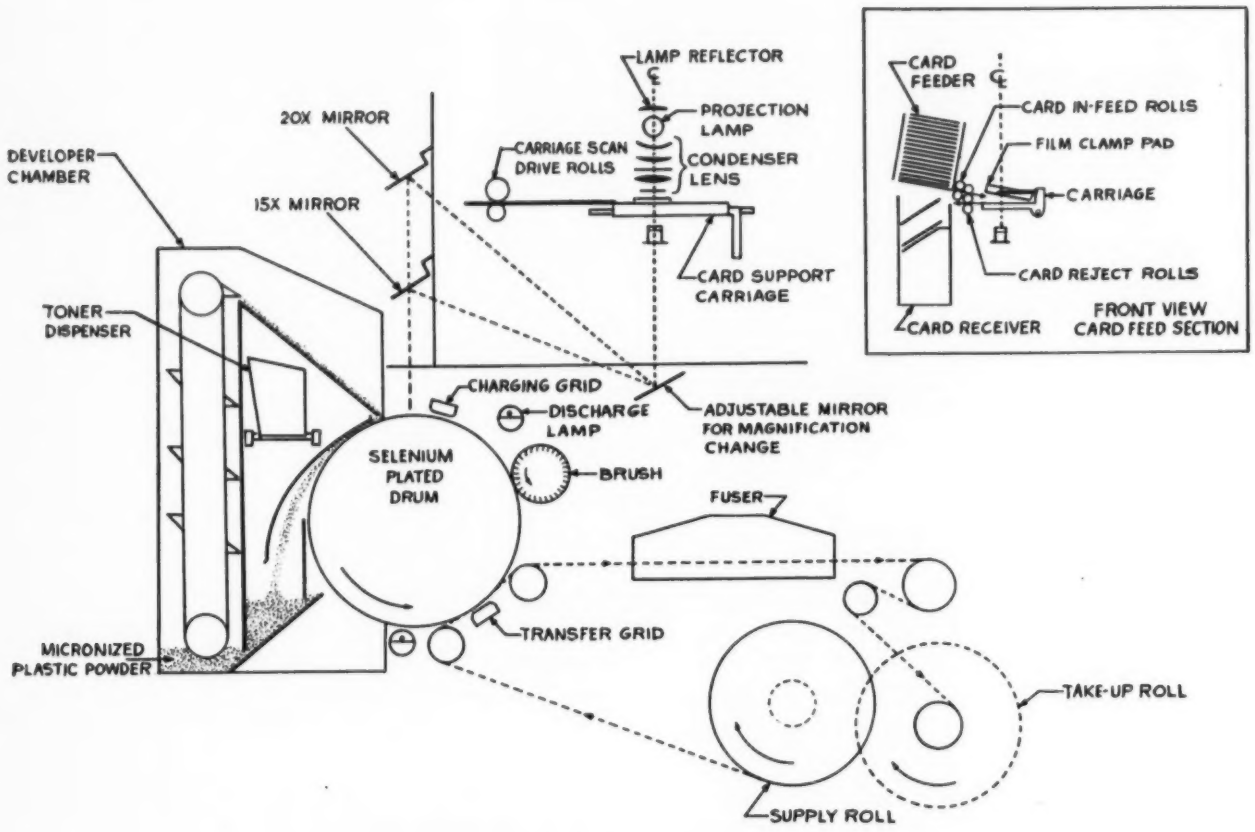
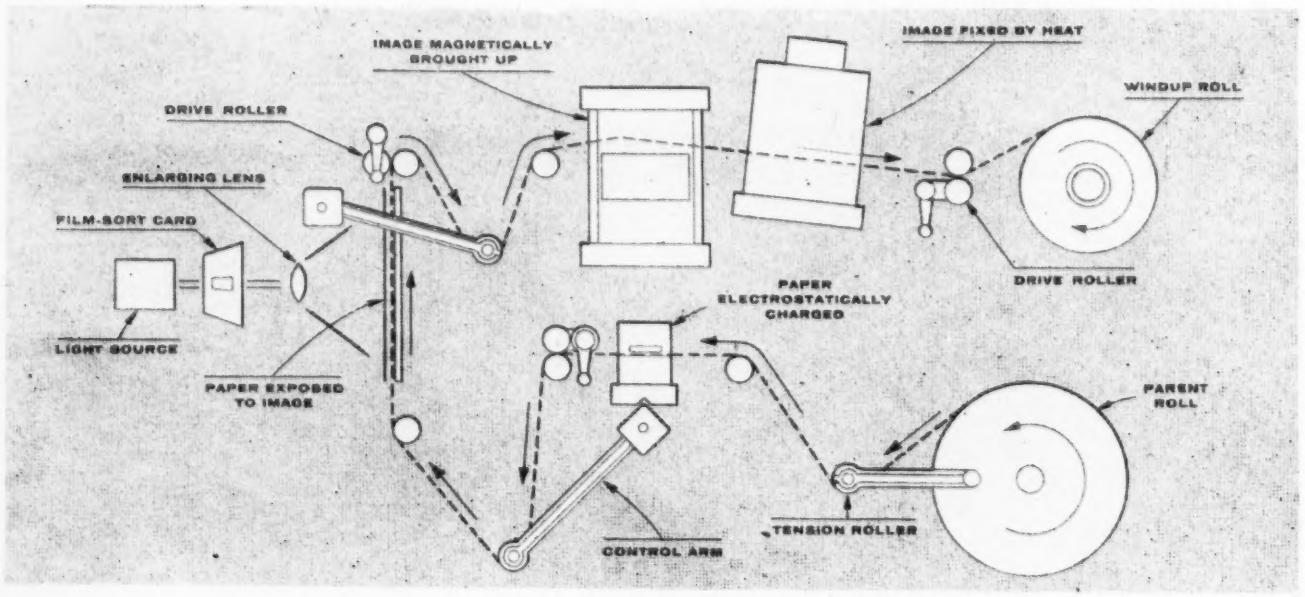


FIG. 11. SCHEMATIC DIAGRAM OF COPYFLO 24" continuous printer. (Drawing courtesy Haloid Co.)

FIG. 12. SCHEMATIC DIAGRAM of RCA BIZMAC Electrofax microfilm enlarger (Drawing courtesy Radio Corporation of America)



produced microfilm positives mounted in apertures in standard computer cards* for automatic sorting and filing. A continuous 24" Copyflo printer makes inexpensive paper prints from the film for bench use.

Experiments with this prototype system, recently exhibited at ASO, Philadelphia, are being coordinated with other naval offices, the Army Signal Corps, and the Air Force to ensure that equipment developed will also fulfill the requirements of all potential users.

The Aviation Supply Offices's present problem in storage and handling of the large-size Van Dykes and blueprints now required of all aircraft systems contractors is illustrated in Fig. 6. Naval contractors are now required to furnish ASO three Van Dykes and twelve blueprints of each drawing; these cost $9.60. Under the new system the contractor will furnish a roll of microfilm containing all the equipment drawings, with blank EAM (Electronic Accounting Machine) cards on which the identifying data for each drawing has been punched and typed. Each card is then reproduced to a Filmsort card on a standard card punch machine to be used as a master in the Filmsort automatic mounting machine which automatically cuts the microfilm and mounts the film in the aperture. Fig. 8 shows microfilm mounted in the aperture card.

A Filmsort automatic card-to-card printer (Fig. 9) has been developed to duplicate the aperture cards by dry photographic printing, at a cost of ten cents a copy. It is anticipated that all shipments of drawings between naval activities or to large users will be made by transfer of Filmsort cards, which are easily sorted and filed by machine; thus achieving management economy and flexibility. Whenever aircraft are modified, the location and replacement of obsolete drawings by their up-to-date counterparts can be quickly made with a minimum of manpower.

Visual reference to a particular drawing can be accomplished by projecting the microfilm in a reader or by making a 24" xerographic print on the new *Copyflo printer.*

The 24" Copyflo Printer

The Copyflo machine is an application of the xerographic process to continuous production of enlarged prints from microfilm positives. The 24" Copyflo printer is shown in Fig. 10; its operation is shown schematically in Fig. 11.

The aperture card is placed in a card holder which slowly moves the microfilm under the lens system. This motion, when magnified by the optical system, exactly matches the speed of the selenium-coated drum. The electrically-charged surface of the drum is exposed to light only at the narrow slit receiving the projected image of the microfilm. All portions of the drum which are shaded by markings on the film retain their electrical charge and subsequently attract a coating of the developer (dry, negatively-charged, plastic dust).

*International Business Machines Corporation or Remington-Rand Cards.

Next, the roll paper is brought into contact with the drum and charged to attract the powder from the drum onto the paper. The paper then passes under the hot-wire fuser grid which melts the powder, forming the permanent black marks which constitute the lines of the enlarged drawing. Each film may be re-exposed any desired number of times to produce additional copies before the next card is fed into place. The prints are dry and smudge-proof as they come from the machine.

The Electrofax Process

Evaluation of a similar prototype microfilm printer, using the Electrofax* system, is planned at the Naval Air Station, Alameda. This process (Fig. 12), developed under the Bizmac program of the Radio Corporation of America, differs from the xerographic process chiefly in that a coated paper which is sensitized electrostatically just prior to printing, will be used instead of the selenium drum and uncoated paper combination. It is also designed to produce a dry non-smudging image which is fixed by heat. The Bizmac automatic printer is planned to operate from either Filmsort cards or 35mm microfilm rolls to produce a roll of prints 22″ wide.

*Electrofax is a trademark copyrighted by the Radio Corporation of America, Camden, N. J.

Possible Savings of the Navy Filmsort Program at ASO

The extension of the prototype system described at ASO to other Naval air establishments can result in an estimated initial savings on prints of $1.9 million a year, plus $225,000 on filing, inspecting, and handling Naval air prints while another $94,000 is salvageable from warehouse space and filing cabinets no longer required.

Users, such as Alteration and Repair Divisions at Naval air stations, will have similar savings. Mailing costs will be cut to a fraction by the substitution of duplicate Filmsort positives for full-size blueprints or Van Dykes. No files will be required for the paper prints as they will be destroyed. If needed again they can be xerographically reproduced with less cost than that from filing the expended print.

The equipment required to implement the Filmsort-Copyflo system will be: Kalfax card-to card printers, at supply centers only; automatic Copyflo enlargers by large users; manual enlargers by small activities; Filmsort viewers by all using activities.

If results of the evaluation program are satisfactory, it is expected that microfilmed drawings will be issued to all users (who will be encouraged to use viewers to the fullest practical extent to minimize paper costs).

It seems probable that the system will find wide acceptance in other government offices and in industry because it demonstrates practical labor and space-saving techniques in engineering drawing management.

Lit-Bits—*Continued*

High Frequency Autotransformers

Since variable transformers are a necessary component in many control systems, a complete standard line of POWERSTAT variable transformers for high frequency use is offered. Most standard POWERSTATS designed for 60-cycle duty can be operated satisfactorily at frequencies of 400 cps and higher.

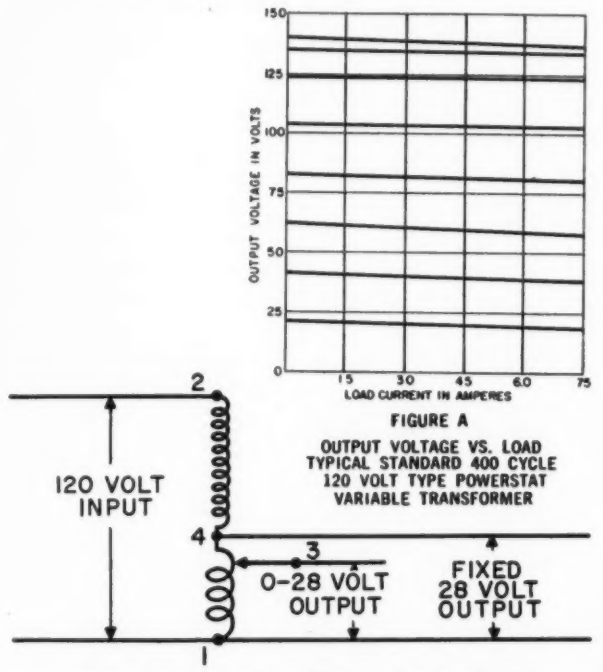


FIGURE A
OUTPUT VOLTAGE VS. LOAD
TYPICAL STANDARD 400 CYCLE
120 VOLT TYPE POWERSTAT
VARIABLE TRANSFORMER

Circuit Diagram for TYPE 1RHS03UK and TYPE 1RHS03US

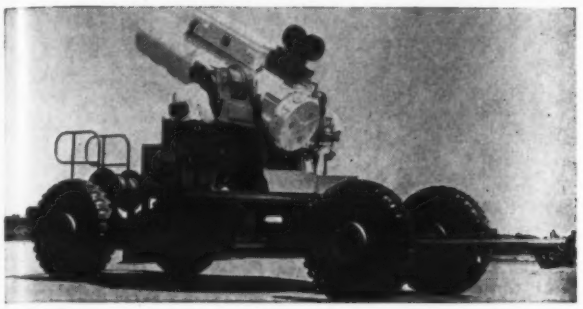
However, when weight and space is a factor, POWERSTATS specifically designed for 400-cycle service will perform the same task as a comparably rated 60-cycle POWERSTAT, but will weigh only one-third as much and occupy only one-half the cubic space.

POWERSTAT variable transformers are autotransformers of toroidal core design with a movable-brush tap. Rotation of the brush tap by manual or motor-driven means produces a continuously-adjustable output voltage from a-c power sources. (*From new 28-page Bulletin P 257H that provides ratings, photos, dimension and circuit drawings and descriptions, The Superior Electric Company, Dept.* 257, 83 *Laurel St., Bristol, Conn.*)

For this literature circle **107** on inquiry card.

"Moon" or Missile?

Guided-missile tracking equipment requires an intimate combination of optics, electronics, and mechanics in integrated optical system. One such system, the Telescopic Photographic Recorder (TPR), is a transportable recording single-telescope instrument designed to visually track and record the flight of missiles, jet aircraft, and all types of airborne objects. As part of a missile-tracking network, it affords complete and accurate information on missile velocity, acceleration,



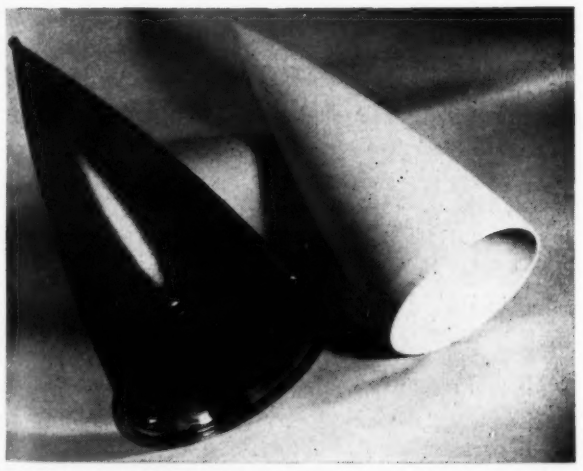
OBJECT 2" x 4" can be photographed while at 4-mile altitude.

spin rates, attitude, and spatial position. In addition, it provides a photographic record of the missile and angular data (space coordinates) and correlated time data on film. The TPR has unlimited azimuth rotation and an elevation of 100°, from 10° below the horizon to 90° at zenith. (*From 16-page Brochure "Optical Tracking Instruments" by Perkin-Elmer Corp., Norwalk, Conn.*)

For this literature circle **108** on inquiry card.

Pyroceram

Pyroceram is the name given by Corning Glass Works to extremely hard, fine-grained crystalline materials formed from special glasses. Since the size, density and chemical composition of its crystals can be controlled, properties of Pyroceram can be tailored to meet specific requirements.



MISSILE RADOMES made from Pyroceram, before and after the heat treatment that induces crystal growth, turns material from transparent noncrystalline into opaque crystalline.

Possessing a high ratio of strength to weight, Pyroceram Code 8605 has a modulus of rupture (flexural strength) of 37,000 psi. There is very little loss of strength at temperatures up to 700°C (1300°F). Deformation temperatures range up to 1350°C (2460°F). In comparative diamond indentation tests it has been found harder than flint, granite or hardened high-carbon steel (65 Rockwell C), but not as hard as sapphire. (*From new 4-page bulletin, Corning Glass Works, Corning, N. Y.*)

For this literature circle **109** on inquiry card.

SERVOS

In the preceding discussion, the extensive use of servos in aircraft, marine, and land based equipment was emphasized. Now we examine how a servo operates.

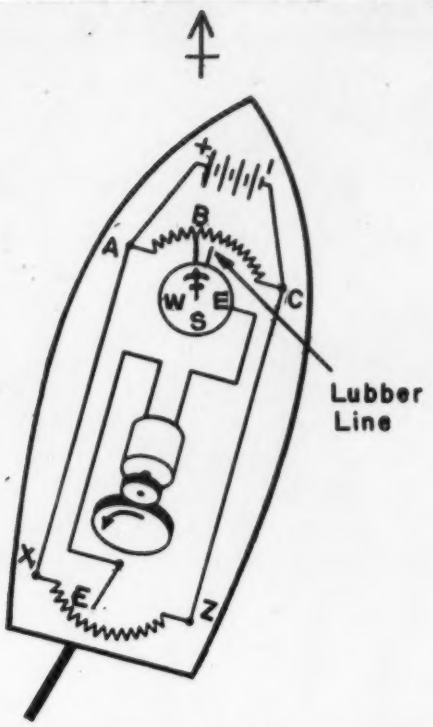


FIG. 1. SHIP'S AUTOMATIC pilot is a simple servo system.

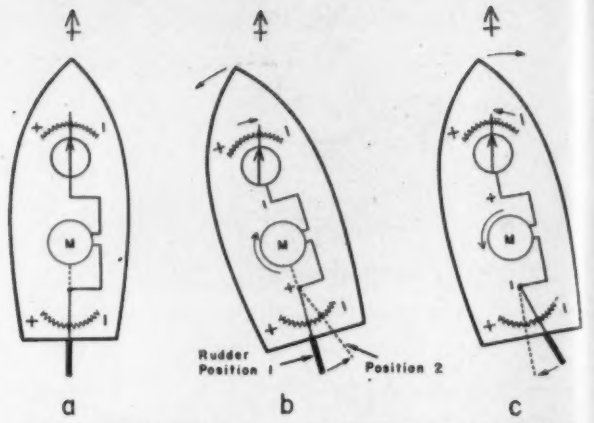


FIG. 2. UNBALANCE BETWEEN potentiometers produces rudder-angle change to correct heading

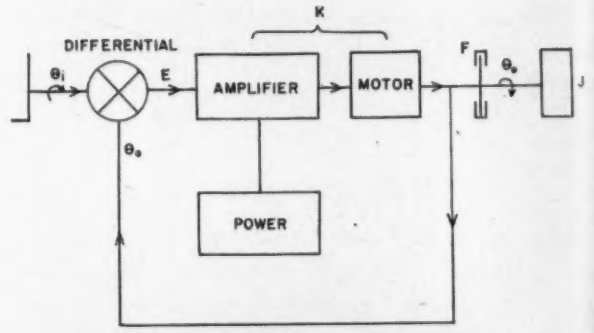


FIG. 3. SCHEMATIC of servo system

A SIMPLE servo system is needed in the gyro-pilot or "Iron-Mike" of a ship. In order to understand this mechanism, which functionally replaces the helmsman, let us first analyze the actions of the human helmsman who is ordered to steer a certain compass course, say 000° true. Looking at the compass he notes that the ship's head is reading—say, 020° true. As this is farther to the right than he should steer, he "ports his helm" by turning the wheel counter-clockwise causing the rudder to swing left, and the ship slowly changes course to the left until it is on bearing 000°. If he doesn't change the rudder angle at this point, the bow of the ship will continue to swing left until an error exists in the other direction, when the helmsman must steer "hard right" to correct the swing of the ship to port. In fact, an inexpert helmsman can soon have a ship weaving a serpentine path through the seas. The trick, of course, is to ease off the rudder as the ship nears the correct bearing.

Now let's design a simple servomechanism to replace the helmsman. First, the sensing element for a simple form of "Iron Mike" autopilot can be a compass needle that moves the arm of the potentiometer as shown in Fig. 1. A second potentiometer is attached to the rudder to sense rudder angle. If the ship is carried off the correct heading by wind or current, the needle swings to one side as in Fig. 2. Current will flow from point E to B through the steering motor which turns until the rudder is in position 2. This causes the ship to start changing its heading and the compass needle slowly swings back to its center position. As it does, point B becomes positive with respect to E, and the steering motor slowly turns the rudder back amidships, bringing the ship to the correct heading.

In an actual ship installation, a gyro-compass repeater would be used instead of the north-pointing needle of a magnetic compass, and a powerful amplifier would be used to magnify the weak signal current produced by the unbalance between the two potentiometers. Also a pair of synchros can be used instead of potentiometers to develop the error signal. However, any servomechanism will employ the same principles as we have illustrated above and will involve: (a) Sensing an error, (b) amplifying the error signal, (c) applying the amplified error signal to an actuator which corrects the error, and (d) feedback of position information. These elements are shown in Fig. 3 in schematic symbols.

Servo Response

The servo system shown in Fig. 3 consists of an input device (in this case a turning shaft) connected through a differential which indicates the error or difference between output and input (in this case angles). The amplifier and motor combination produces a torque that is directly proportional to the error. That is, $T = KE$.

The friction device shown represents all types of viscous friction in the system, including certain resistances, magnetic drag, and all other frictions which are directly proportional to speed. (Static friction or "stiction," which resists starting, is ignored in this consideration.)

By definition, an error angle E will produce a torque KE. This torque (produced by the amplifier and motor) must exactly equal the retarding forces due to inertia and viscous friction.

The inertia force is $J\, d^2\theta_0/dt^2$.

The viscous friction drag is $F\, d\theta_0/dt$.

Therefore,

$$KE = Jd^2\theta_0/dt^2 + F\, d\theta_0/dt \qquad (1)$$

If we wish to express this equation in terms of input and error (θ_i and E), as is customary, we can use the relation:

$$E = \theta_i - \theta_0$$

or

$$\theta_0 = \theta_i - E \qquad (2)$$

and substituting in equation (1) we have

$$KE = J\frac{d^2\theta_i}{dt^2} - J\frac{d^2E}{dt^2} + F\frac{d\theta_i}{dt} - F\frac{dE}{dt}$$

or

$$J\frac{d^2E}{dt^2} + F\frac{dE}{dt} + KE = J\frac{d^2\theta_i}{dt^2} + F\frac{d\theta_i}{dt} \qquad (3)$$

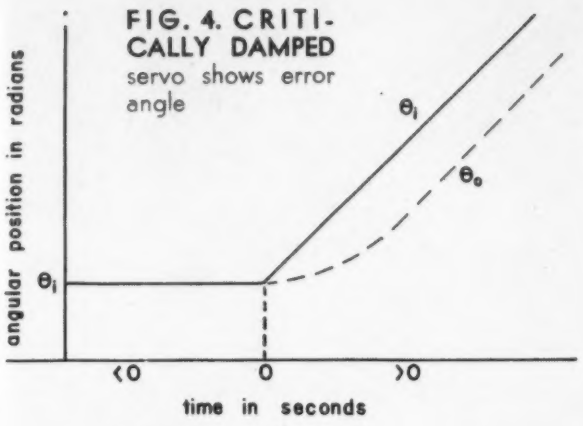


FIG. 4. CRITICALLY DAMPED servo shows error angle

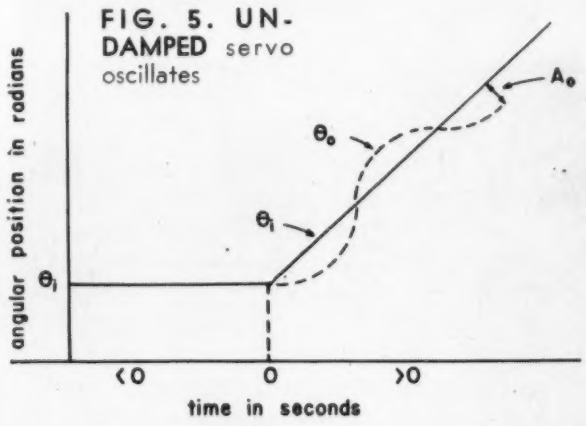


FIG. 5. UNDAMPED servo oscillates

This basic equation defines the response of a closed-loop servo system having inertia (J), viscous friction (F), and position-type feedback ($\theta_i - \theta_o$)

Transient Response to Step Change in Position

If a sudden change in position angle is imparted to the input

$$t < 0, \theta_i = \theta_1$$

but at time $$t \geqq 0, \theta_i = \theta_2$$

This says simply that the input shaft is suddenly changed from position θ_1 to position θ_2. At all times, except for a negligible region where $t = 0$ the constant angular velocity of the shaft is effectively zero —that is, the shaft is not rotating continuously. As $d\theta_i/dt$ and $d^2\theta_i/dt^2$ are zero, equation 3 becomes

$$J\frac{d^2E}{dt^2} + F\frac{dE}{dt} = -KE \qquad (4)$$

Equation (4) gives the response of the system to a step change in input position—that is, the transient response.

This differential equation has as its solution the exponential function

$$E_T = A\epsilon^{pt} \qquad (5)$$

where E_T is the transient error and ϵ is the base of natural logarithms, and A and p are are constants. The first and second derivitives of this function are $dE_T/dt = pA\epsilon^{pt}$, and $d^2E_T/dt^2 = p^2A\epsilon^{pt}$

Substituting in (4), the solution of equation (4) is:

$$Jp^2A\epsilon^{pt} + FpA\epsilon^{pt} + KA\epsilon^{pt} = 0 \qquad (6)$$

or

$$A\epsilon^{pt}(Jp^2 + Fp + K) = 0$$

As the quantity in parenthesis must be equal to 0:

$$Jp^2 + Fp + K = 0$$

The roots of this quadratic equation give p:

$$p_1 = -\frac{F}{2J} + \sqrt{\frac{F^2}{4J^2} - \frac{K}{J}} \qquad (7)$$

and

$$p_2 = -\frac{F}{2J} - \sqrt{\frac{F^2}{4J^2} - \frac{K}{J}} \qquad (8)$$

From these values, two solutions for E_T are obtained:

$$E_{T1} = A_1\epsilon^{p_1 t} \qquad (9)$$

$$E_{T2} = A_2\epsilon^{p_2 t} \qquad (10)$$

which are added to produce the general solution:

$$\theta_T = A_1\epsilon^{p_1 t} + A_2\epsilon^{p_2 t} \qquad (11)$$

Depending on the values of F, K, and J, the quantity under the radical in (7) and (8) may be positive, negative or zero. If positive, it can be shown that the system is overdamped or sluggish in response. This is an undesirable characteristic for most servo applications. If negative, the system will tend to go into oscillation, with a natural frequency (radians/sec) of

$$F_n = \sqrt{K/J} \qquad (12)$$

If the quantity under the radical (equation 7 or 8) is zero, the system is said to be critically damped; that is, the error will approach a steady state value without oscillation or hunting. The value of output damping F_c at which the system is critically damped is

$$F_c = 2\sqrt{KJ} \qquad (13)$$

The discussion of the transient conditions has been considered independent of any continuous velocity of input rotation, because servos often function through changes of position only. Furthermore, the transient characteristics of any servo are independent of the constant input velocity, being dependent solely on the parameters J, F, and K.

Step Change in Velocity

In certain servo applications a sudden change in input *velocity* (rather than a change in angular position) is imparted to the system. If the input θ_i is initially at position θ_1 and at zero velocity,

$$t < 0, \quad \theta_i = \theta_1, \quad \omega = 0$$

but

$$t \geqq 0, \theta_i = \theta_1 + \omega_1 t, \omega = \omega_1 \text{ (a constant)} \qquad (14)$$

the output cannot follow the input exactly. Instead an initial period in which the *transient response* is dominant will quickly change into a *steady state* condition as the transient response fades out. Neither the transient, the steady state response, nor their momentary combination will be exactly like the input. Substituting the values of equation (14) in (3) we have

$$J\frac{d^2E}{dt^2} + F\frac{dE}{dt} + KE =$$

$$J\frac{d^2\theta_i}{dt^2} + J\frac{d^2(\omega_1 t)}{dt^2} + F\frac{d\theta_1}{dt} + F\frac{d(\omega_1 t)}{dt} \qquad (15)$$

Since θ_1 is a constant, the first and third terms on the right are zero. Also, for constant angular velocity ω_1, $d(\omega_1 t)/dt = \omega_1$ and $d^2(\omega t)/dt^2 = 0$. Equation 15 then reduces to

$$J\frac{d^2E}{dt^2} + F\frac{dE}{dt} + KE = F\omega_1 \qquad (16)$$

Steady-State Error Angle

In a critically damped servo (Fig. 4) the output velocity eventually becomes equivalent to the input velocity, although a difference E in phase angle between θ_i and θ_o remains as long as ω remains constant. When E is constant both the first and second terms of the left-hand member (Eq. 16) reduce to zero, leaving:

$$KE = F\omega_1$$

$$E = F\omega_1/K \qquad (18)$$

which defines the *steady-state error angle* as being determined by the viscous friction, the input velocity, and the amplification constant. Note that this is true only when ω_1 is constant, after the transient error has vanished. The value of F_c for critical damping has been given by equation (13).

The undamped condition of the servomechanism with a step change in rotational *velocity* is shown in Fig. 5, which shows the natural oscillation frequency of the system (equation 12) superimposed on the input velocity ω_1. The oscillation drives the output position θ_o alternately ahead of and behind θ_i in position. The amplitude A_o of the oscillation is:

$$A_o = \omega_1/\sqrt{K/J} \qquad (19)$$

Underdamped System

The undamped and critically-damped conditions are limits between which the practical servo system is often operated as an *underdamped* system. In many applications where a large steady-state error cannot be tolerated, but where a damped oscillation resulting from sudden changes in input speed does not lead to serious complications, a value of F somewhat less than F_c is used as a compromise. The damping ratio c is then the ratio between the actual friction F and the value Fc needed to provide critical damping or

$$c = \frac{F}{F_c} \text{ or } c = \frac{F}{2\sqrt{KJ}} \qquad (20)$$

The foregoing has considered some of the parameters of a simple servomechanism relying on viscous damping to reduce oscillation. This type of damping produces a steady-state error which is undesirable in high-accuracy applications, such as fire-control servos. However a more sophisticated form of damping is possible called error-rate damping, as well as non-frictional forms of viscous damping, which will be explained in forthcoming articles of this series.

TOUCH-DOWN STRAIN PROVES LAB TESTS OK

Goodyear Tire and Rubber Co.
Wheel and Brake Div.

BONDED resistance-wire strain gages were used recently to measure both strain distribution and all of the pure component loads that produce the strains in a double-purpose test of aircraft-landing-gear structural parts and design specifications.

This method was devised in order to take the tests out of the laboratory and permit extensive strain measurements in a landing gear under loads produced by actual take-offs, landings and other ground maneuvers under normal and extreme conditions. All loads and strains were recorded by a 12-channel oscillograph, which, along with accessories, could be carried in the airplane (Fig. 1).

The main problem solved before making the flight tests was how to make the selective measurement of the four component loads—radial, side, drag, and caster (Fig. 2). Although caster load is not important to ordinary wheels it was included for cross-wind wheels. In addition, brake loads were measured. Tests were made on the left gear only of a tail-wheel type D18S Beech aircraft with 11.00-12 wheels and fork type gear.

Two procedures were employed to make sure that the Baldwin SR-4 resistance-wire strain gage transducers would measure the applied loads accurately. The first was to choose the locations for the gages by use of stresscoat, a strain indicating coating. This showed the location, direction, and magnitude of the maximum strains resulting from applied loads.

The second procedure (after bonding the gages at the selected strain points on the landing gear) was to find the proper combinations of gages in Wheatstone-bridge circuits so that only pure component loads would be measured and the strains introduced by loads other than the one being measured would be cancelled out.

Only one bridge circuit was found that would measure radial load with sufficient sensitivity. It comprised four resistance-wire strain gages on the vertical parts of the fork. Although the sensitivity was not high (350 micro-inches per inch per G), the output was linear from 0 to 4.5 G's. Two satisfactory bridges were found for each of the other loads—side, drag, and caster. Each included four selected SR-4 strain gages bonded on the fork. All bridge circuits were made self temperature-compensating.

Since radial load is probably the most important of the loads measured, other transducers for measuring radial load were also developed and flight tested. The most convenient transducer of this type was a resistance-wire strain gage pressure cell connected to the inflating inlet of the oleo system, because it provided for recording pressure changes in the same way as load and strain sensing gages. The pressure gage used was merely an aluminum tube closed at one end, with two strain gages on the outside wall to measure the swell of the tube. As a substitute for this pressure cell two other resistance-wire strain gages were bonded to the outside of the steel oleo cylinder itself.

Another radial load transducer measured the in-and-out motion of the oleo piston. A rheostat (Helipot) was attached to a pin of the scissors linkage and rotated by one arm of the scissors as the piston moved in and out.

Tire pressure also was used as a measure of radial load and required development of a special diaphragm. This was a pressure-sensitive Durez diaphragm installed between the tube well of the wheel and the inner tube. The resulting pressure cell had a sensitivity four to five times that possible with a diaphragm of aluminum.

A strain gage pressure cell similar to that used on the oleo was used to measure brake pressure. Seven copper-mercury rotating connections were developed because strain gages on the wheel would be rotating. A contactor on the commutator sensed each wheel revolution so that rpm and wheel position during peak strain also would be recorded. Eleven strain gages were attached to the brake and 58 gages on the wheel for these strain measurements.

All flight test records were made by oscillograph using six channels for loads and six for strains. A movie camera trained on the flight instruments was synchronized with the oscillograph.

The tests proved laboratory test requirements are much greater than the loads which actually occur in flight service and confirmed the belief that the laboratory is a satisfactory proving ground.

Fig. 1. Flight tests of landing gear loads and stresses require a 12-channel S-12A Hathaway oscillograph, switching equipment (two 6-channel Hathaway Model MRC-12) for more than 100 Baldwin SR-4 strain gages, and a 16 mm Cine Kodak Special movie camera trained on flight instruments.

Fig. 2. Resistance wire strain gages on this landing gear measure both operating strains and the component loads that produce them.

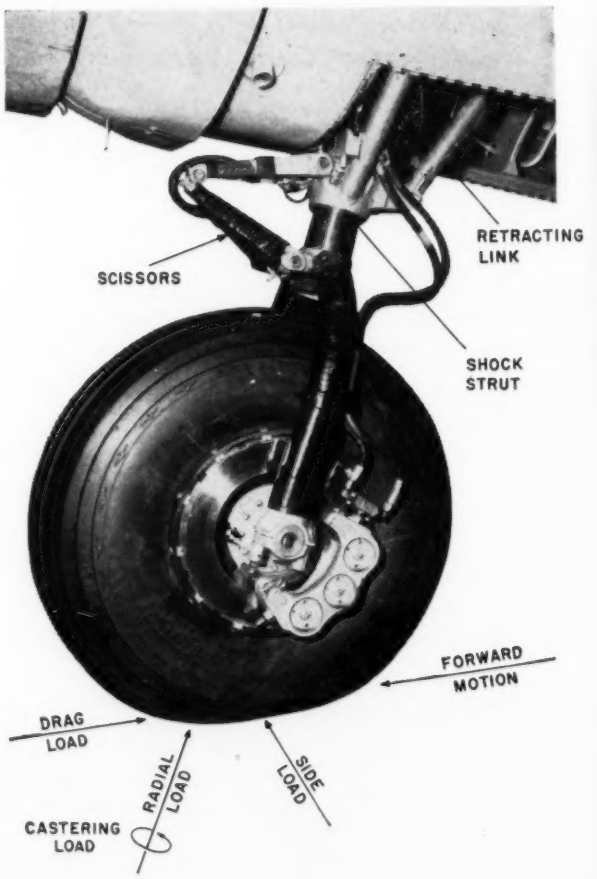


Fig. 1. NAVIGATOR is powered by two 200 hp Cummins Diesels and one 170 hp Caterpillar Diesel. Engine room also contains a 10 kw d-c generator, a 3 kw a-c generator and a 10kw shaft generator.

Floating Test Lab

A 93-foot triple-screw "NAVIGATOR" (Fig. 1), is being used by Belock Instrument Corp. as a floating laboratory and demonstration vessel for advanced electronic navigational aids.

On board is a complete gyro-compass system with repeater compasses, a magnetic compass system with Tele-Transmission to repeater compasses, radar and the Belock "Auto-Navigation" system consisting of a Dead Reckoning Analyzer and Loran (Fig. 2). Other equipment includes a radio direction finder, electric steering stand with gyro-compass repeater, magnetic steering compass, ship-to-shore radio telephone and several new devices currently under development.

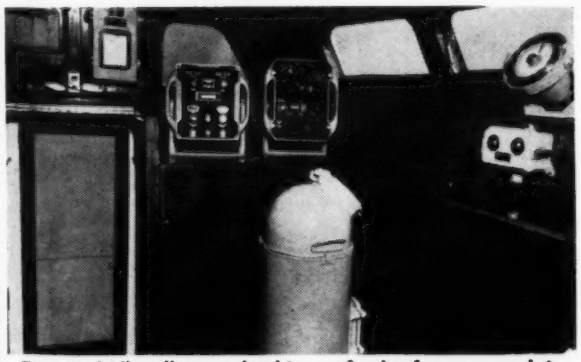


Fig. 2. Wheelhouse looking aft. In foreground is stand containing master magnetic compass and the Tele-Transmission system which transmits its readings to repeaters. At the right of the master magnetic compass stand is the magnetic compass system's meter panel. Directly over the meter panel is the bracket-mounted magnetic compass repeater, used here as a bulkhead repeater. Directly behind the master magnetic compass stand are the two units of the Belock "Auto-Navigation" system. The unit on the left is the new Dead Reckoning Analyzer, which automatically provides direct readings of ship's latitude and longitude from inputs of initial position, speed and course. On its right is the Loran unit. Left of the "DRA" unit is the course recorder which operates as a unit of the Gyro-Compass system. To the left of the course recorder is a depth recorder.

For more information on Belock Navigational Instruments Circle **207** on inquiry card.

RADAR RESTITUTOR MAKES MAPS FROM RADAR DISPLAYS

USING RADAR for either mapping or charting of selected targets or entire areas depends on restitution of the available intelligence to eliminate distortion. A device that automatically performs this restitution has been introduced by Fairchild Camera and Instrument Corp.

Radar measures the time it takes for a burst of electromagnetic waves to go from the ranging station to a target and return. This echo time is directly related to the distance of the target from the radar set. When the radar is airborne and at some altitude, the range displayed on the indicator will be the distance (slant range) from the ground target to the aircraft. For mapping purposes it is necessary to know the ground range of the target from the nadir point (directly below aircraft). This conversion is *slant-to-ground range correction.*

Echoes from targets located directly underneath the aircraft at the nadir point will be received after a finite interval of time, corresponding to the time it takes light to travel from the aircraft to the nadir point and back. The radar indicator displays a target at a distance from the center of the cathode-ray tube which is proportional to this echo time. The nadir point will thus be displayed at a finite distance from the screen center. As the antenna makes a complete circular scan, the cathode-ray tube will show the nadir point as a circle of a certain radius. This circle is often termed the *altitude hole.* A time delay is sometimes introduced into the cathode-ray sweep circuit so that the altitude hole will be contracted to a point and the nadir will be displayed at the center of the presentation. Introducing a time delay converts target positions from slant range to ground range for small values of ground range, but distorts the position of targets having larger ground-range positions. This is *sweep delay distortion.*

Another error in airborne radar displays is due to the fact that the radar ranging station is moving, but the visual presentation of echoes ignores this motion that is significant for a full 360° scan.

If the echoes are positioned at a distance from the display center which is not proportional to the echo time, then a further distortion will result. This would

generally be caused by the fact that the velocity of the electron beam across the cathode-ray tube screen is not uniform.

When the cathode-ray tube display is photographed, two more distortions occur. First, the tube face is curved and the camera lens will project it onto a flat film, thus distorting the geometrical relationship. Second, the camera lens itself does a little distorting.

Radar PPI photograph is placed in restituting chamber. Film cassette above will record the same image, but it will be free of the distortions from slant range, sweep delay and plane motion during one scan.

The radar presentation restitutor corrects for the following distortions: (a) Distortion due to the recording of the slant range, (b) distortion due to sweep delay and (c) distortion due to plane motion during one scan.

Provision also has been made to introduce corrections for: (d) Distortions due to non-linear electronic sweep, (e) lens distortion, and (f) curvature of cathode-ray tube, or any other, range distortion.

Distortions a, b, and c are computed and corrected automatically with no computations required of the operator.

Test results have shown the accuracy of the restitutor to be well within 4 parts per thousand. The equipment qualifies well for field use by unskilled operators, since no computations are required and the equipment is operable under ambient light conditions. The present design is capable of being extended to correct for "tilt" distortion.

For information on Fairchild Radar Restitution circle **204** on inquiry card.

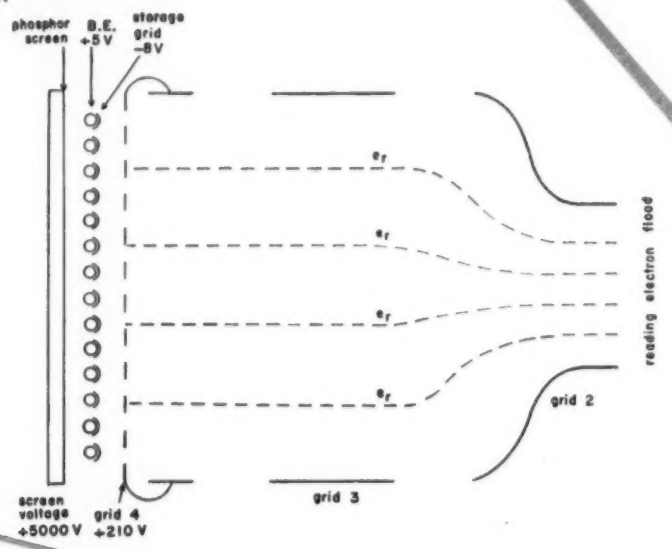


FIG. 2. DETAIL OF READING elements in RCA 6866 Storage Tube.

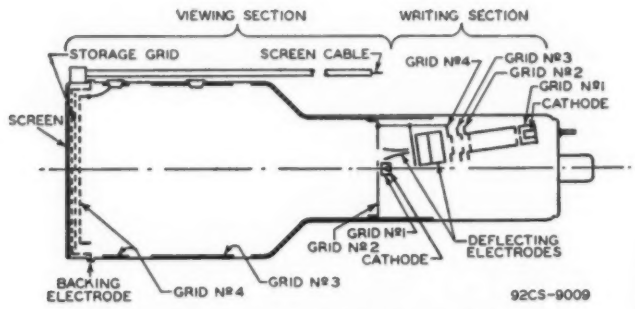


FIG. 1. RCA 6866 STORAGE TUBE schematic diagram. (Courtesy Radio Corporation of America)

Display/Storage Tubes

The Charactron shaped-beam display tube was described in our May-June issue. Other display or storage tubes include the RCA 6866; the Hughes Typotron® Memotron® and Tonotron®; the Raytheon QK464 recording tube; the American Machine & Foundry Company's Digitron; the Intercontinental Electronics Corporation's Picture Transformer; and the Farnsworth Iatron.

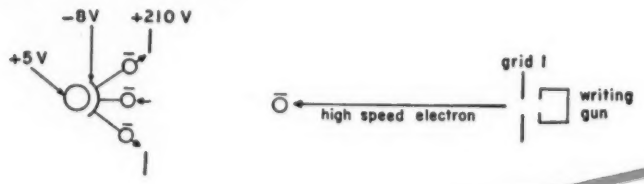


FIG. 3. HIGH SPEED writing-beam electron frees additional electrons by impact, leaving storage grid element more positive.

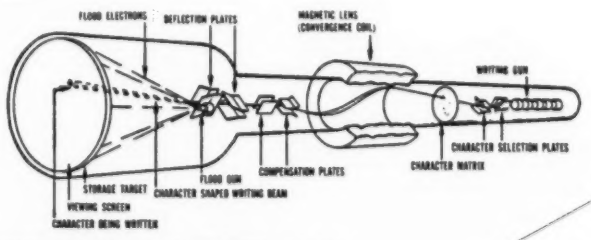


FIG. 4. TYPOTRON COMBINES matrix-shaped characters, electrostatically positioned, with storage capability. (Courtesy Hughes Products)

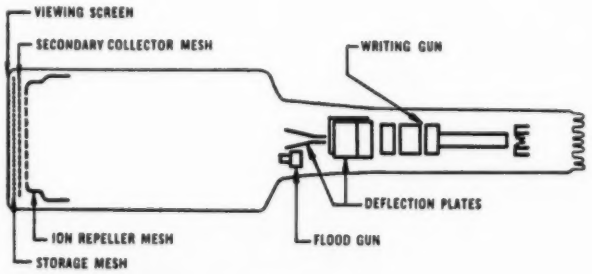


FIG. 5. MEMOTRON DIRECT display storage tube permits retention of transient waveforms until intentionally erased. (Courtesy Hughes Products)

THE ABILITY to freeze microsecond transients for the length of time necessary to measure or photograph them is often desirable. The RCA 6866 is explained in some detail to explain the basic principle of storage tube operation also used in modified forms by certain other display systems.

RCA 6866

The RCA 6866 storage tube is a 5-inch display storage tube designed for applications where a bright nonflickering display of stored information is desired for about 60 seconds after writing has ceased. Performance of the 6866 when operated with 10,000 volts on the screen is characterized by a 4″-diameter display having brightness of 2750 foot-lamberts; good resolution capability in half-tone displays; and a writing speed of about 300,000 inches per second—a speed sufficiently fast to freeze microsecond transients for the time necessary to examine, measure, or photograph them.

The 6866 uses two electron guns, a writing gun with electrostatic focusing and deflection, and a viewing gun which floods the electrodes controlling the storage function and the brightness of the display with a relatively low-velocity, unfocused shower of electrons. Construction of the storage tube is shown schematically in Fig. 1. A close-up of the reading elements near the screen is seen in Fig. 2. The phosphor-covered inner surface of the screen, at far left, is charged to a positive 10-kv with respect to the viewing-gun cathode. Next to the screen is a metallic fine-screen mesh called the backing electrode, normally charged to +5 volts with respect to the viewing-gun cathode. A thin coating of insulating material is deposited on the side of the backing electrode facing the writing cathode. This deposit is the storage grid. Each element of the storage grid receives or loses its charge by gaining or losing electrons as a result of the scanning action of the writing beam and not by conduction, as do the other grids. A short distance to the right of the storage grid is another wire screen, called grid 4, which serves among other functions to accelerate the electrons in the writing beam. Grid 3 in the viewing section collimates (makes parallel) the paths of the electrons in the viewing stream before they reach grid 4 so that they will approach the storage grid in paths perpendicular to the plane of the storage grid.

The writing-beam gun is similar to a conventional cathode-ray-tube gun with electrostatic focusing and deflecting electrodes, and produces a well-defined focused beam with an exceptionally small effective area at the storage grid. The purpose of the writing beam is to control the charge on the storage grid. The cathode of the writing gun is usually from 1.5 to 2.5 kv negative with respect to the viewing-gun cathode.

The storage grid serves to control the viewing beam so that stored information can be displayed on the screen. Its control action is similar to that of the grid in a negative-grid triode. With the storage grid at zero potential, most of the viewing-beam electrons are accelerated through the storage grid and backing electrode, strike the screen, and cause it to fluoresce brightly over its entire area. The current to the screen can be cut-off as a result of pulsing the backing electrode positive above its usual positive dc operating potential. At the conclusion of the pulse, having a duration of about 100 milliseconds, all elements of the storage grid are left with a negative potential nearly equal in value to the amplitude of the applied positive pulse. This negative potential cuts off the screen current. Under cutoff conditions, viewing electrons are turned aside to be captured by grid 4.

After the viewing-beam current has reached normal value, the writing beam is activiated. This high-speed sharply focused beam is made to scan the elements of the storage grid. The electrons which land on the storage grid produce secondary emission at the storage grid (Fig. 3). This means that more electrons leave the storage grid than arrive. Those elements on the storage grid scanned by the beam assume a less-negative charge wherever the writing beam strikes. The potential of any storage element determines the number of viewing-beam electrons passing through the storage grid in the immediate vicinity of that element. (A less negative potential tends to increase that number.) When the potential is such as to allow passage of electrons, these electrons are accelerated and strike the screen directly opposite the storage element producing a luminous spot. A charge pattern established by the writing gun on the storage grid produces a corresponding visible pattern on the screen which may be observed for a period up to about one minute after writing has ceased.

Viewing duration of the display after the writing has ceased is limited by the presence of positive ions produced by collision of electrons in the viewing beam with residual traces of gas in the region between the screen and grid No. 4. These positive ions are attracted to the most negative elements of the storage grid. On landing, they cause an increased flow of viewing-beam electrons to the screen. The limit of viewing duration, therefore, is determined by loss of contrast in the viewed pattern.

The stored pattern is erased by applying to the backing electrode a positive pulse or series of pulses. The RCA 6866 tube is in quantity production.

Hughes Memory Tubes

The Hughes Products Co. Typotron® character display-storage tube (Fig. 4) combines the shaped-beam features of the Charactron tube, using the McNaney character matrix (but with electrostatic positioning) with a storage principle similar to that previously described for the RCA 6866. The Typotron is 5 3/8″ in diameter, and its storage ability enhances its application to low-speed photographic-recording applications.

Hughes also produces the Tonotron® storage tube (designed for retaining half-tone images) and the Memotron® direct display storage tube in which one or several transients can be retained until intentionally erased.

This erasing feature is made possible by an additional ion repeller mesh behind the viewing screen (Fig. 5). A dielectric-coated storage mesh retains a charge pattern whereever it is struck by the writing beam. A positive-charged secondary-electron mesh (directly behind the storage mesh) collects secondary electrons, preventing them from neutralizing the charge on the storage mesh. The stored image, achieved by the secondary emission characteristics of the storage mesh, is continuously reproduced and visually displayed on the phosphor-coated tube face by a low-velocity beam of electrons from the flood gun. The flood electrons are emitted through the charged areas and receive additional energy from the post-accelerating potential applied to the viewing screen. The image is erased by momentarily lowering the secondary- collector voltage, thus permitting the electrons which were retained at the collector mesh to neutralize the positive or "written" portions of the storage dielectric.

FIG. 6. INTEC PICTURE transformer writes radar information with one beam, reads it off as TV information with second beam, permits combination of radar and graphic air-traffic control symbols. (Courtesy Intercontinental Electronics Corp.)

Picture Transformer

Intercontinental Electronics Corporation (INTEC) of Mineola, New York, has demonstrated its Picture Transformer system (Fig. 6) at the CAA Technical Development Center, Indianapolis. This converts radar information into television signals that can be displayed and transmitted with conventional television techniques. This permits aircraft identity information to be added to a radar display.

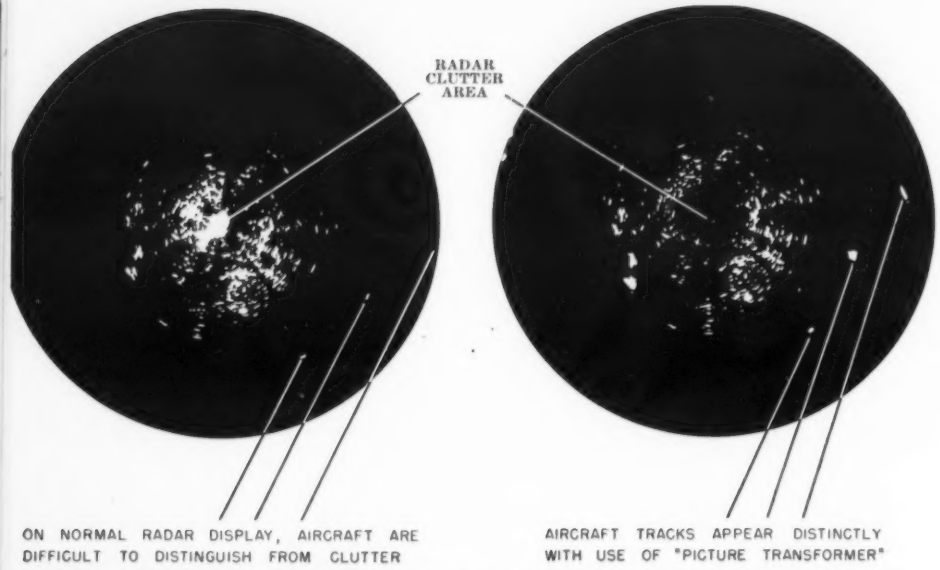


FIG. 7. AIRCRAFT TRACKS on display at right are improved by action of INTEC picture transformer.

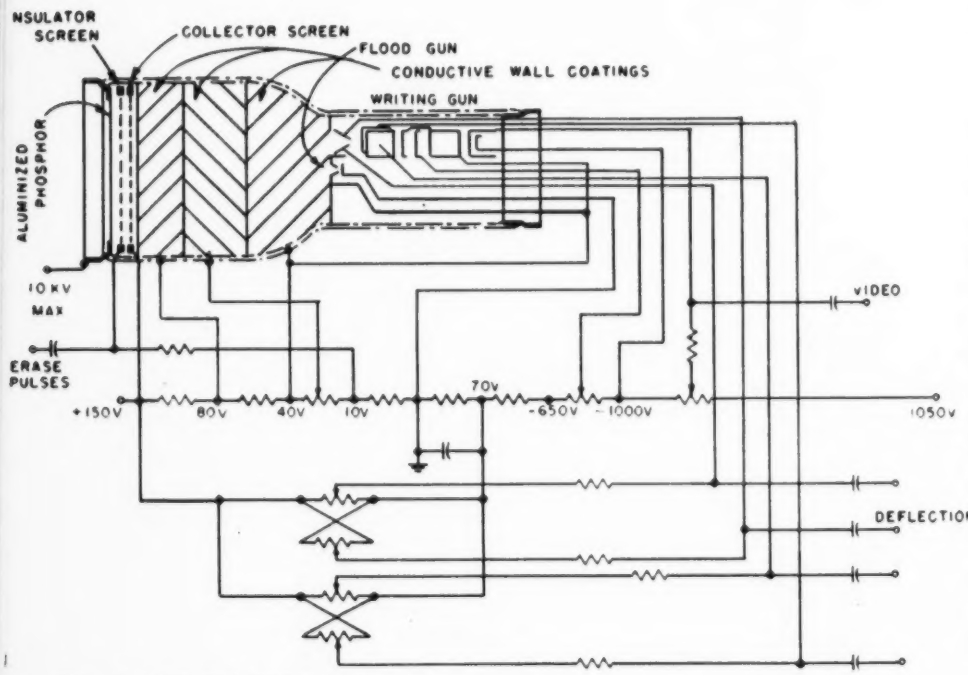
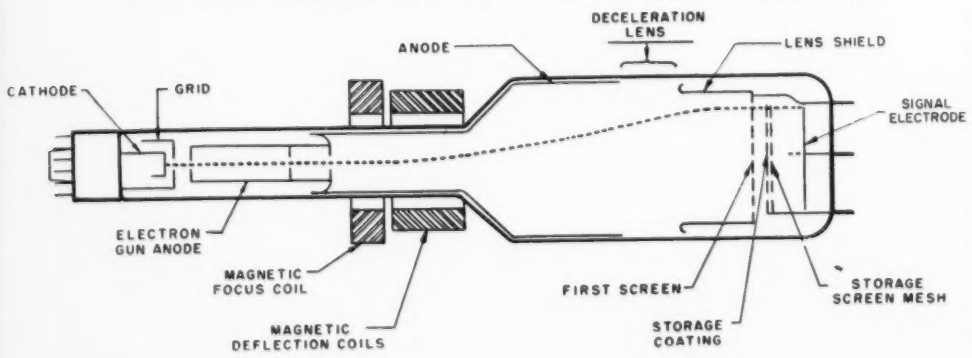


FIG. 8. IATRON STORAGE Tube schematic (Courtesy Farnsworth Electronics Co.)

FIG. 9. QK 464 RECORDING Tube (Courtesy Raytheon Mfg. Co.)



The Picture Transformer System was invented and developed by French engineers of the Compagnie Generale de Telegraphie Sans Fil (CSF). The transformer tube is said to be a two-gun memory tube that writes information with one electron beam (radar information) on an internal storage surface and independently reads the information from the surface with the other beam (television information). Unique advantages claimed are its high resolution capability, its controllable memory, the improved freedom from interference effects, and the broad contrast range in the picture it produces (Fig. 7).

Iatron

The Farnsworth 5″ Iatron storage tube (Fig. 8) is similar in principle to the RCA 6866, described previously. In the Iatron, partial erasure uses pulses between 1 and 2 milliseconds in duration repeated 60 times per second to permit bright-trace continuous-line oscilloscope study of low-speed transients. The Iatron is available for distribution by the Farnsworth Electronics Co., Fort Wayne, Ind., a division of the International Telephone and Telegraph Corporation.

Digitron

The American Machine & Foundry Co. Digitron display equipment (demonstrated at the 1957 IRE National Conference in New York) presents a rectangular raster (display grid) of 24 horizontal and 16 vertical characters. The Digitron equipment uses a beam-writing technique to produce a page-printing format on a 19″ Dumont type K 1202-P12 cathode ray tube, which uses conventional magnetic and electrostatic deflection elements. Character-tracing wave forms are generated by the character stroke generator unit in response to a program of impulses set up in the program control unit and the character selection unit which are parts of the Digitron character generator circuit. Waveforms for the character "Q" are shown in Fig. 11. Alpha-numeric symbols display any desired message within the 384-character raster—rather than geographically referenced plan-position presentation of target symbols (Fig. 10.)

Raytheon Tube

The Raytheon QK464 Recording tube is a storage tube which does not furnish a direct image, but provides a signal output to be viewed on a separate radar or television tube (Fig. 9). The storage coating on the storage screen mesh is similar to that described for the RCA 6866. However, a single electron gun is used to scan the storage mesh when reading as well as when writing. The electron beam during "read" is modulated by the charge pattern which has been "written", so that the output current collected by the signal electrode is a function of the stored signal. If this signal is applied to the grid of a standard CRT which has its deflection synchronized with that of the storage tube, the stored information is reproduced for viewing.

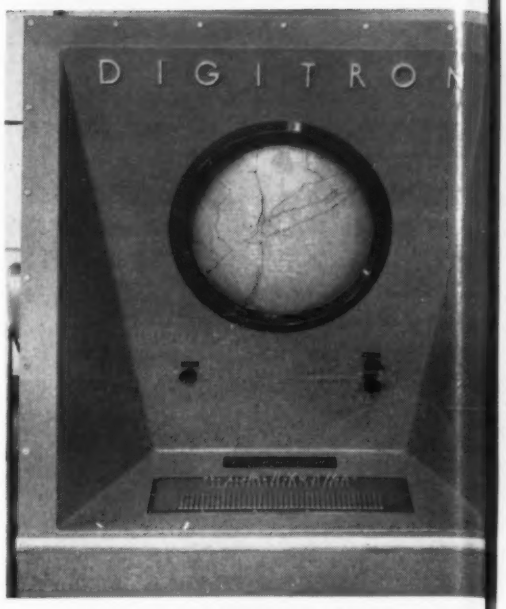
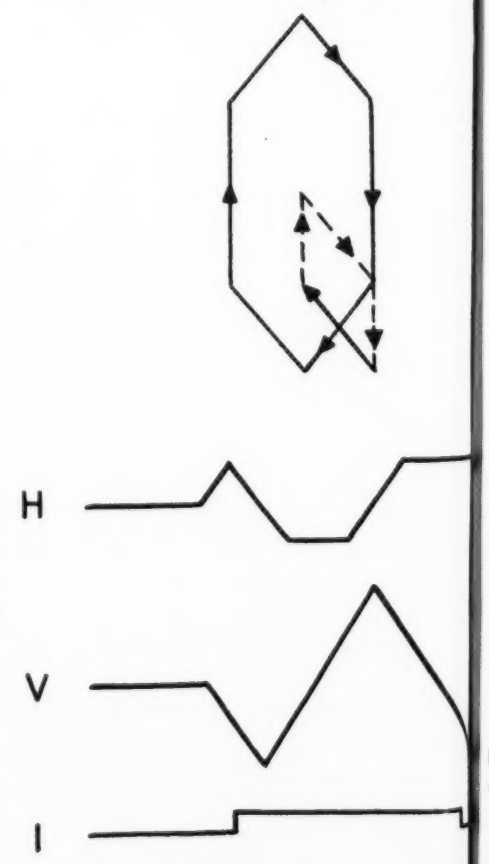


FIG. 10. DIGITRON CHARACTER Display Equipment (Courtesy American Machine & Foundry Co.)

FIG. 11. HORIZONTAL and vertical deflection voltages are controlled by Digitron equipment to write letter "Q" on face of display tube.



Remote Vehicle Control Has Valuable Military Applications

REMOTE-CONTROL equipped vehicles can obtain data from remote, hazardous, or otherwise inaccessible areas via television and also perform hazardous rescue and transport service.

The equipment is easily installed in any tracked or wheeled vehicle and uses electromechanical actuators controlled by radio or through an electrical cable which permits a variety of driver locations (Fig. 1). Quick switch-over from manual to remote control is easily accomplished.

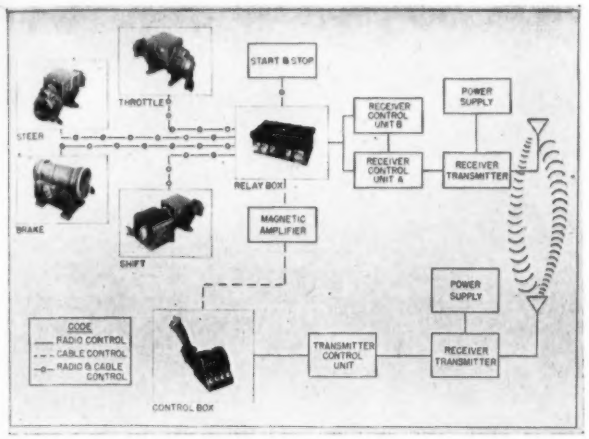


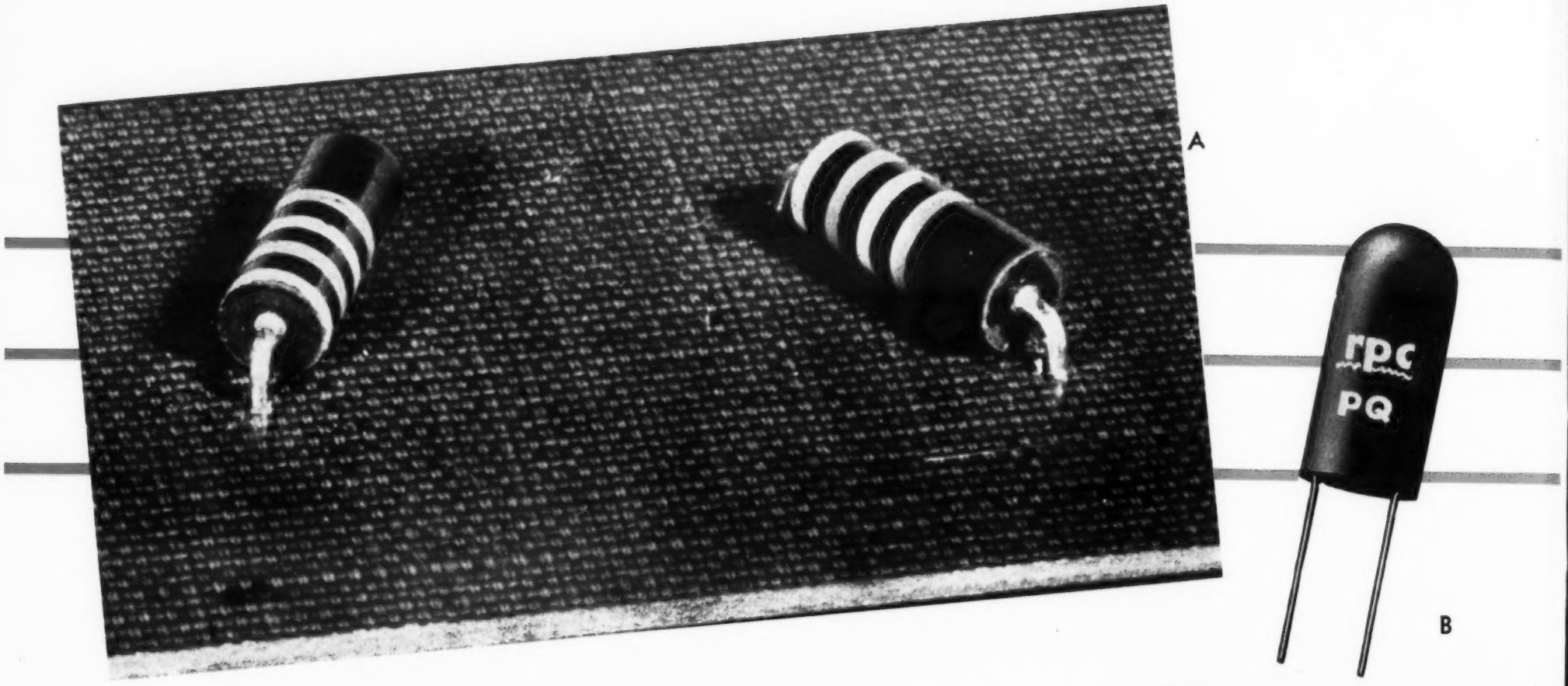
FIG. 1. BLOCK DIAGRAM of remote vehicle control shows actuators linked through relay box to radio receiver or control cable.

A push button starts the engine; and an aircraft-type control stick steers the vehicle with right-and-left movement and controls the throttle with fore-and-aft movement. Moving the control stick all the way to the rear position applies the brake. Other push buttons shift the vehicle into any gear selected by the operator.

The rugged system, introduced by Lear, Inc., Grand Rapids, Mich., is designed to operate under the most extreme environmental conditions; it has been used in testing US Marine Corps landing vehicles under dangerous surf conditions (Fig. 2).

FIG. 2. MARINE CORPS LVT is guided through rough surf by remote control in helicopter.

For information on Lear Remote Vehicle Control circle **205** on inquiry card.



Printed Circuitry

IV—COMPONENTS

Choice of components is a significant factor affecting printed-circuit design and application. This chapter describes the many components available for use in printed circuits, including standard, redesigned, and printed components.

ALLAN LYTEL, General Electric Company

PRINTED CIRCUITS use (a) *standard components* mounted either directly to the board or through connectors, adapters, sockets, etc., (b) *components redesigned* for use in printed circuits—usually to facilitate machine mounting, and (c) *printed components* made by the same techniques used for making printed wiring. Fig. 4-1 illustrates these three alternatives using a resistor as an example.

After the board is printed, holes can be punched through the conductors for insertion of the component leads or component sockets and connectors. Fig. 4-2 shows socket layouts for seven-pin and nine-pin tubes. Both of these are used in miniaturized equipments. A grid system divides the boards into squares 0.1″ on each side. This hole layout scheme permits accurate determination of hole location. The large center hole allows the

Fig. 4-1. Components used can be standard, modified or printed types. A shows direct mounting of standard resistor on base board. B shows one of wire-wound resistors redesigned for insertion in printed circuits. C shows amplifier board—printed resistors show up as black bars. (Photo A courtesy General Mills, photo B courtesy Resistance Products Co., photo C courtesy Centralab.)

tube socket to fit through the board. Each pin of the tube socket has a lug which projects through the small peripheral holes. The tube is mounted in the socket from one side of the board and the components are mounted on the other side.

Standard Components

Fig. 4-3 shows method for lead attachment for standard components. Holes are located on the board so the leads project through to the wiring side of the board. First the leads of the components are bent down (either by hand or by machine) and inserted in the proper holes. Then the leads are crimped to make a firm physical connection. The leads may be crimped so that they face each other, or are in opposite directions, or are at right angles. Soldering completes the process. These axial-lead components are an example of conventional unmodified parts used with printed wiring.

The board shown in Fig. 4-3 has been made with "plated-holes"—the holes through the board have been plated with copper. The component lead has been inserted in the plated opening—solder joins the lead and the copper plating. In variations of this technique eyelets are sometimes used to provide a more secure connection between the copper-foil wiring and the leads.

Modified Components

Components are now being produced with different types of leads which are more successfully inserted by machine. A disk capacitor is shown in Fig. 4-4. In A, pin terminals are shown. These are two short parallel leads which fit directly into the holes in the board. A standard grid system, such as the 0.1" grid, is required so that the lead spacing matches the holes located by the grid system. The same capacitor with axial leads is shown in part B. Here bending is required, in either of the two ways shown. At C, special tapered leads provide a force fit into the holes. This makes a better mechanical connection between the board and the leads than obtained with the straight-wire leads. Many components—small transformers, volume controls, resistors, capacitors, switches, and others—are now being made with such special leads for mounting on printed boards.

Some of these modified components are shown in Fig. 4-5. Part A shows a ceramic coil form. It is ¼" in diameter and either ⅝" or 13/16" long and designed with solder lugs for dip-soldering. Part B shows three cylindrical filter capacitors. Part C shows an on-off-control with parallel lugs for insertion.

Printed Components

Many circuits known as "printed circuits" are only printed wiring. An actual *printed circuit* has not only printed wiring but also printed components.

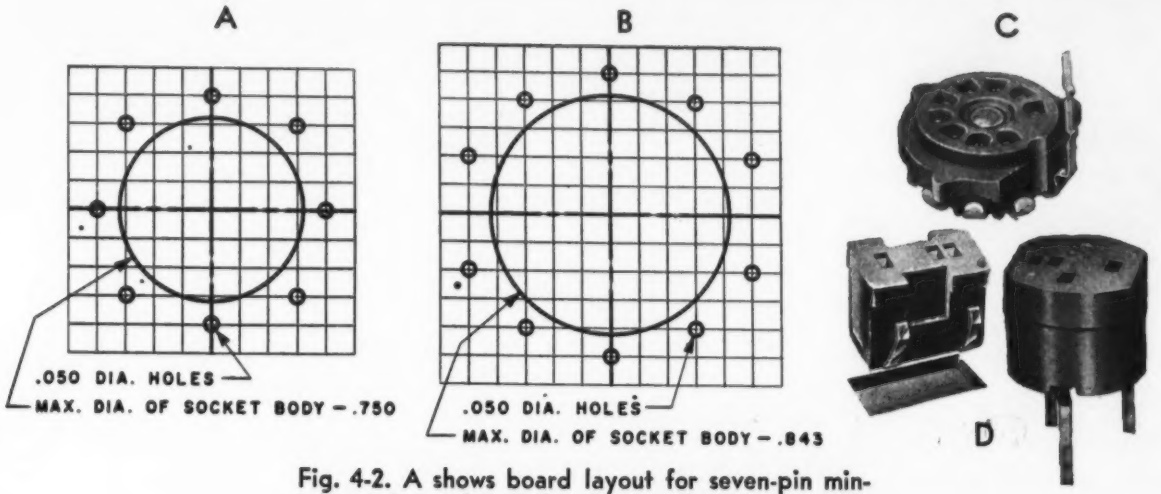


Fig. 4-2. A shows board layout for seven-pin miniature tube socket. B shows layout for nine-pin socket. C shows the socket that receives the nine-pin tube and mounts on the board. D shows similar sockets for transistors. (Photos courtesy ELCO)

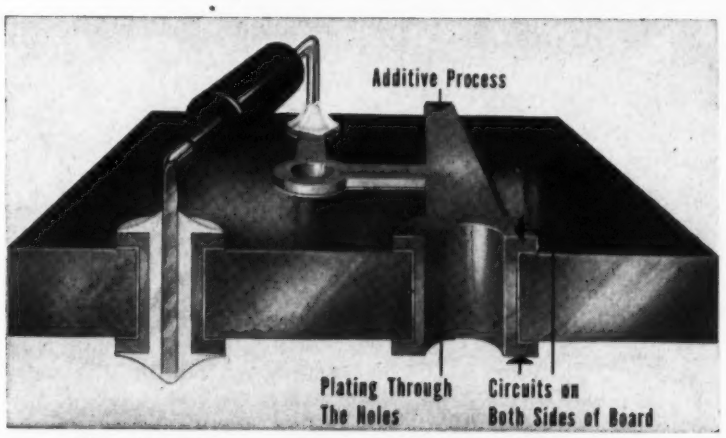


Fig. 4-3 Cross section of "THRU-CON" board. (Drawing courtesy General Electric Co.)

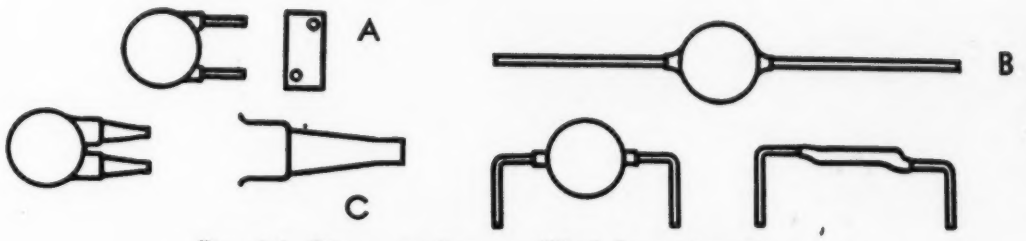


Fig. 4-4. Disc capacitors modified for automatic insertion in printed boards. A shows pin terminals; B shows two ways of bending straight leads; C shows tapered, flat leads.

Fig. 4-5. Components modified for use in printed circuits. A shows ceramic coil form. B shows plug-in capacitors. C shows on-off-control. (Photo A courtesy Cambridge Thermionics, photo B courtesy RCA, photo C courtesy Clarostat.)

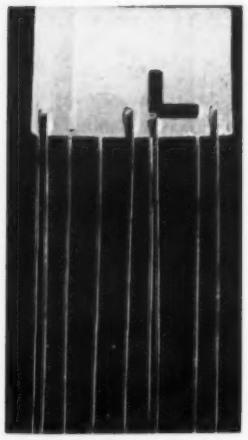


Fig. 4-6. Resistors and capacitors in a single circuit using the base material as the dielectric. (Photo courtesy Centralab)

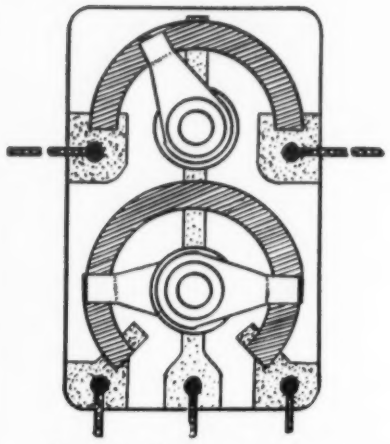


Fig. 4-7. Trimmer resistors for use with transistors. (Drawings courtesy Centralab)

Fig. 4-8. Tape-wound resistor. (Photo courtesy National Bureau of Standards)

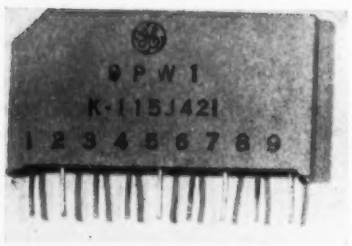


Fig. 4-9. Encapsulated within a molded phenolic case, these new resistor-capacitor networks are designed for such applications as coupling, pulse-forming, and R-C filter networks. (Photo courtesy General Electric Co.)

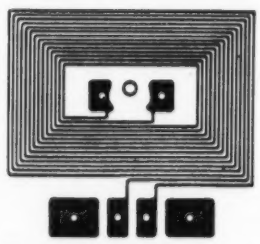
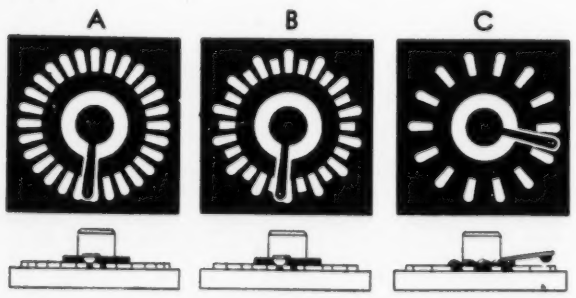


Fig. 4-10. Printed coil. (Drawing courtesy RCA)

Fig. 4-11. A, shorting switch; B, non-shorting switch; C, cam-action switch. (Drawings courtesy Photocircuits Corp.)



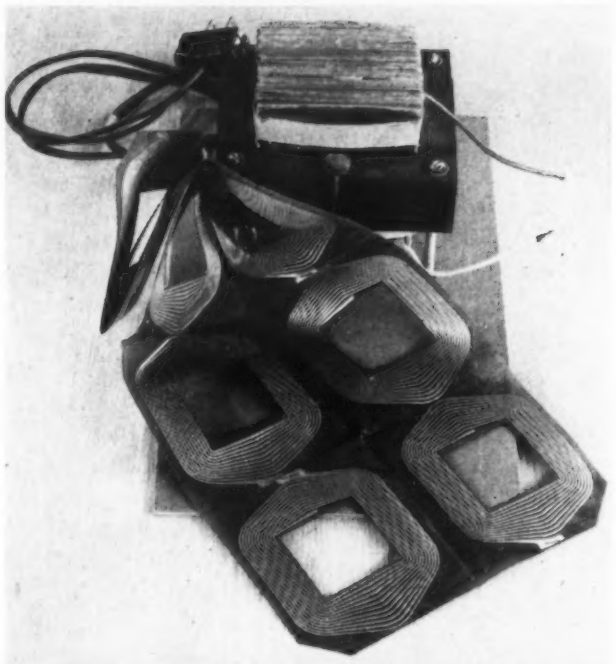


Fig. 4-12. Printed spirals fold up into transformer. (Photo courtesy Technograph Inc.)

In a sense, the use of "printing" techniques for components is not new; India ink was used as a resistance element in early radios. It is possible to vary the width and thickness of the inked line and produce a wide range of resistances.

Capacitors

Capacitors can be made in two ways. If both sides of the board are copper plated, the insulation between them acts as the dielectric. This is the parallel-plate capacitor. This type has been made with values of between 200 and 300 micromicrofarads per square inch, and with a frequency range up to 1000 megacycles per second.

The second method is to use interlocking "fingers" on a single side of the board. The base material again acts as the capacitor dielectric, but it is more difficult to obtain the higher values of capacity.

Both of these methods can be modified to make part of the components used with printed wiring. For example, Fig. 4-6 shows capacitors using paint on a base of ceramic material. The light parts of the base are capacitor plates and the dark parts are painted resistors. This is an example of an additive process because the capacitors and resistors are both added to the base. There are no wires of any type, printed or otherwise, between these components because they are in direct contact. Leads connect this printed circuit (group of printed components) into a larger circuit; either another printed circuit or a conventional circuit.

The basic difficulties encountered with printed capacitors are: 1. Values must be restricted to rather small capacitance or a great deal of precious board space is used. 2. It can be difficult to maintain an exact control of value, which is a function of the printing process and the thickness of the board. 3. Characteristics of the capacitors vary with operating temperature and the frequency of operation.

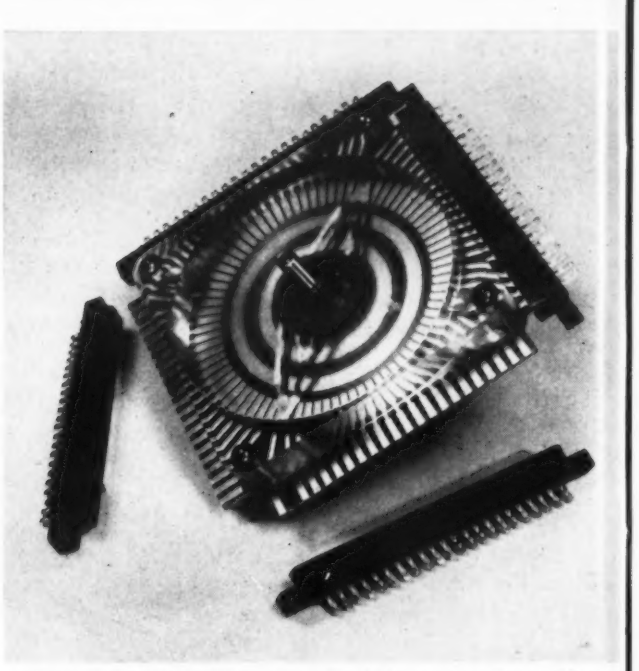


Fig. 4-13. Switching circuit. (Photo courtesy Photocircuits Corp.)

Resistors

Of all the electrical components, the resistor has been probably the most widely used as a part of the printing process. Inks of many types have been used to print resistors from values as low as 50 ohms up to the megohm range. The ink may be printed, sprayed, or painted on the surface, using a stencil to put the resistor in the proper place.

Printed resistors can be produced to normal tolerances of ± 20%; in some cases production runs have been made with better tolerances. Dissipation of about one watt per square inch is average for printed resistors on phenolic boards. With a ceramic base material about four watts per square inch can be dissipated. These ratings indicate that only low power ratings can be used for these resistors unless they take up a rather large area.

Among the most successful applications of the printing process used for components are the National Bureau of Standards tape resistor, the Elargol Process using both carbon and silver, and the Fairchild method of printing on glass.

Fig. 4-8 shows a *tape-wound resistor* comprising a strip of resistance tape wound on a cylinder of insulating material. Leads are connected to both ends and the resistor is sealed in place in a niche in the ceramic wafer.

In transistor circuits there is often a need for a small variable, or trimmer, resistor. This *trimmer resistor* is used to vary the applied voltages and total circuit resistance so that transistors with different characteristics can be used in the same circuit. For example, replacing transistors in a hearing aid is more simple because the circuit values can be adjusted with a trimmer. Their construction is indicated in Fig. 4-7, actual size is not greater than 0.680″ x 0.431″ x 0.1″.

Large-area conductors in close contact with a heat sink provide successful *power resistors.* Thin insulating films with both excellent heat-transfer characteristics and

PLATING	PURPOSE	PLATING	PURPOSE
a) Silver, flash immersion	Short term protection against corrosion.	h) Nickel-rhodium, electroplated 0.00025" to 0.0005" nickel plus 0.000005" to 0.00004" rhodium[1]	Hard, non-corrosive, wear-resistant wiping contact surface. Good for intermittent and continuous operation.
b) Silver, electroplated 0.0001" to 0.002"	Good slow speed switch contact surface.	i) Silver-rhodium, electroplated 0.00025" to 0.0005" Silver plus 0.000005" to 0.00001" rhodium	Good non-corrosive wiping contact surface. Used where rf rules out nickel because of its ferro-magnetic properties.
c) Solder (60% tin 40% lead), electroplated 0.0005" to 0.002"	Excellent soldering aid		
d) Gold, flash immersion	Protection against corrosion and a soldering aid.		
e) Gold, electroplated 0.0001" to 0.0002"	Good electrical non-wiping contact surface.		
f) Indium, electroplated 0.0002" to 0.0005"	Good non-corrosive electrical contact surface.		
g) Nickel, electroplated 0.00025" to 0.0005"	Hard, wear-resistant wiping contact surface.		

[1]Recommended for commutators and wiping switches. In the flush-type arrangements, with the proper choice of base materials and under light brush pressures, a life upwards of 10 million revolutions can be anticipated.

Table 4-1. Plating materials and their switch applications. (Table courtesy Photocircuits Corp.)

electrical insulating properties are required. Experimental units have used the metal case or a metal chassis (if one is used in the equipment) as the heat sink; in some cases a metal sandwich is made with a metal plate, the cabinet or chassis, and the printed resistor in between. These resistors have the advantages of space savings, low cost, long life, and a low operating temperature.

Encapsulation in an epoxy resin inside a molded phenolic case provides printed resistor-capacitor networks shown in Fig. 4-9 with high resistance to heat-humidity cycling. Uniform case surface and an index chamfer on the upper left case corner facilitate magazine loading for automatic placement in assembly.

Inductors

Inductors can be printed on the ordinary circuit board in several ways. Fig. 4-10 shows an inductor printed as a spiral (i-f transformers). A series of straight lines arranged in back-forth fashion are used for r-f coils.

Such printed coils are usually less than 20 microhenries. An inductor with a line width and spacing of 0.01" and covering an area of about one square inch will have an inductance of about 10 microhenries. Depending on the operating frequency and the value of inductance, the Q of such a coil can be between about 50 and 125. Printed-coil values are more readily controlled than are the values of capacitors.

One method of producing an inductance is to repeat a single spiral conductor pattern on flexible insulation and then folding and interconnecting the sheets as shown in Fig. 4-12. A series-connected coil is thus formed. The conductor pattern can be made of any desired width along its length, thereby altering the cross-sectional area of the conductors. For example, the pattern can be designed so that the windings nearest the core are wider than those on the outside of the coil, allowing for better distribution of heat generated in the coil during operation. This transition can be made gradually and precisely as required by design considerations.

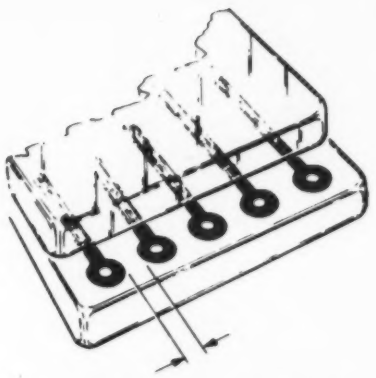
The number of turns in a coil assembly is controlled by the designer and is not subject to operational errors. Also, the placement of each conductor, as well as the spacing between conductors, are under the same precise control. This results in coils having very uniform physical and electrical characteristics. The essentially rectangular cross-section of the conductors provides a very efficient use of the space occupied by the coils. Also, this folding permits intimate inter-relationship between primary windings for greater magnetic efficiency.

Switches

Printed-circuit techniques have been successfully applied to a number of different switches including single and ganged switches for programming, telemetering, and timing. The two general physical types are the raised pattern, where the conductors are on the top of the base surface, and the flush-type, where the conductors are embossed so the surface of the conductor and the surface of the base are in the same plane. The advantage of printed switches is that their cost bears no relation to switch complexity as both simple and complex switch plates are inexpensive when made with printed-circuit techniques.

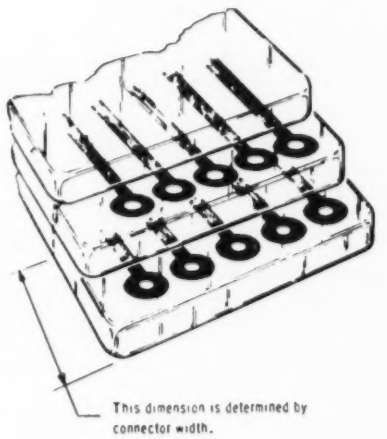
Copper, while it is the best conductor available at low cost, is not well suited for switch contacts because of its poor wearing qualities. Plating overcomes this problem. In some processes, silver is stamped into the base board to produce a pure metallic silver conductor, flush with the surface. To obtain similar characteristics, a copper circuit may be plated by one of the several methods discussed in Chapter 2.

Different plating metals and their applications may be seen in Table 4-1. Nickel, silver, rhodium, and combina-



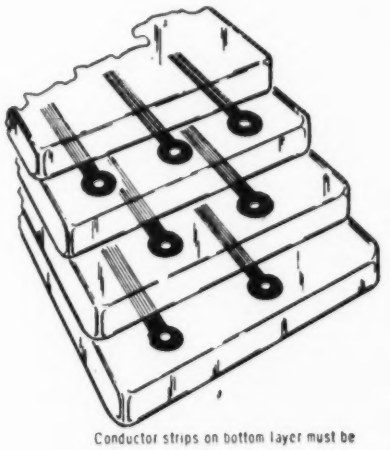
A

Spacing between terminals must be adequate to prevent voltage breakdown.



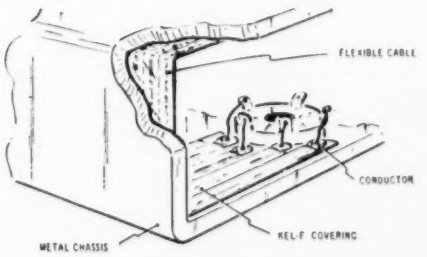
B

This dimension is determined by connector width.



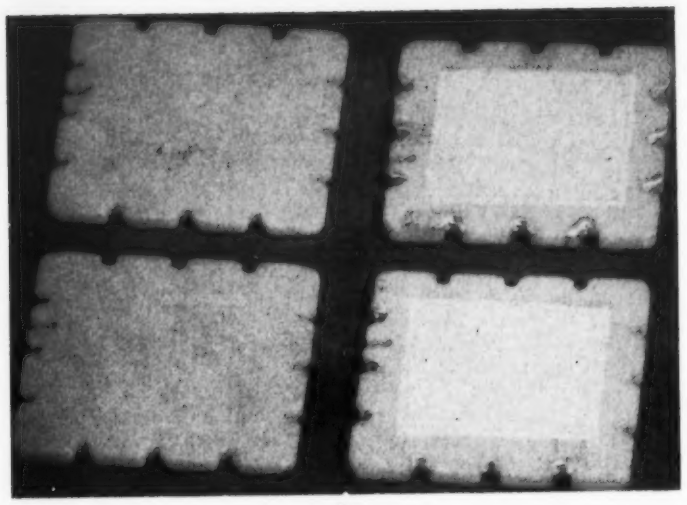
C

Conductor strips on bottom layer must be offset to avoid contact with connector pins inserted through upper layers.

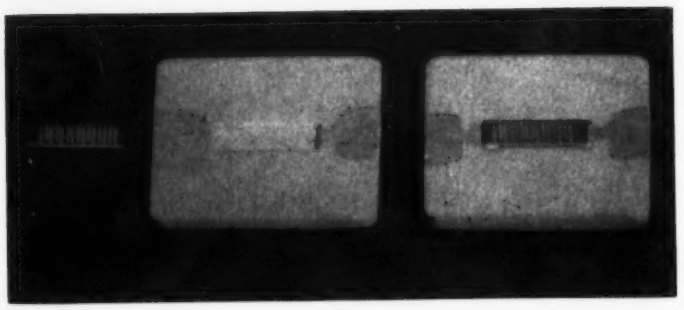


D

Fig. 4-14. Printed cables. A shows a single row, B a double row, C a triple row. D shows flexibility of printed cable. (Drawings courtesy Sanders Associates, Inc.)



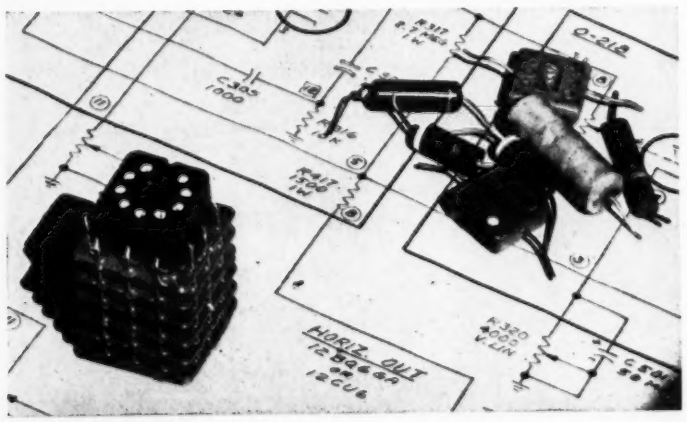
A



B

Fig. 4-15. Printed capacitors. A shows capacitor plates on opposite sides of wafer. B shows interlocking fingers. (Photos courtesy National Bureau of Standards)

Fig. 4-16. Module together with the components replaced by the module. (Photo courtesy ACF Electronics)



COPPER CONDUCTOR PATTERN	PLATING	PLASTIC BASE	SPEED RANGE	LIFE RANGE IN REVOLUTIONS	TYPICAL APPLICATION
Raised	0.001" to 0.003" Silver	Phenolic or Epoxy	Up to 300 rpm	Up to 1,000,000	Hand operated detent switches, high frequency switches.
Raised	0.0005" Nickel with 0.000005" Rhodium	Phenolic or Epoxy	Up to 500 rpm	Up to 5,000,000	Servomechanisms, commutators, slip ring stepping switches.
Raised	0.0005" Nickel with 10- to 20-millionths Rhodium	Phenolic or Epoxy	Up to 500 rpm	Up to 50,000,000	Servomechanisms, commutators, slip ring stepping switches.
Flush	0.0005" Nickel with 20- to 40-millionths Rhodium	Photocircuits black melamine surfaced composite laminate	Up to 2000 rpm	Upwards of 50,000,000	High speed, low torque, bounceless applications.

Table 4-2. Characteristics of printed switch plates ¾" to 1½" radius. (Table courtesy Photocircuits Corp.)

tions of these metals are all used for their excellent wearing qualities. Gold, indium, and solder are used where the wearing is not so severe. Nickel is not used at radio frequencies because the ferro-magnetic characteristics of this metal can introduce noise.

Silver has a special problem; studies have indicated that silver will migrate through the insulator and along the surface under certain conditions of applied voltage and humidity. Not enough data has been presented to make definite statements about the problem of silver migration.

The ordinary phenolic laminate board serves well as the base for many low-power switches but arcing can cause the laminate to carbonize. Epoxy-glass laminates or melamine-surfaced laminates are used because of their superior wearing qualities and resistance to electrical breakdown.

Switch pattern design for raised conductor patterns should prevent bounce of the brush. This can be done in several ways as shown in Fig. 4-11. In A, the brush is wider than the spacing between adjacent switch segments. This shorting switch allows the brush to ride from one contact to the next. In C, a cam raises the brush between switch segments. Any of these methods removes the dependence of switch life upon base-material qualities.

Some characteristics of printed-circuit switches are summarized in Table 4-2. A complex commercial switching device is illustrated in Fig. 4-13. The inner brushes are in constant contact with the printed rings and the outer brush overlaps several contacts to prevent bounce.

Cables

Because the material used is thin, printed cables are flexible and do not take up much room. They can be made with a single layer of conductors, or with several layers (Fig. 4-14). In A, one layer has the wiring and is covered by a top layer of plastic making a compact cable. Current capacity determines width and thickness of the conductors; spacing between the conductors depends on the greatest voltage difference between conductors.

In B, a double thickness is used with two layers of conductors. At each cable termination the wires are staggered to permit connections to pins or to the chassis. In C, the three layers show how the conductors on the bottom layer are offset to avoid contact with the pins meant to make contact with other layers. In D, a printed cable connects parts of a circuit in a chassis to save space.

Flexibility depends on the thickness of the cable; for 0.005" cable the bending radius is 1/16"; for 0.045" cable the bending radius is 2 inches.

Tinkertoy

In the Tinkertoy* method the basic element is a small slab of ceramic material on which components are produced. A stack of wafers, interconnected by vertical wires, makes a completed circuit module.

Fig. 4-15 shows Tinkertoy wafers which contain, or actually are, capacitors. In A, the notched wafer body is the dielectric of the capacitor. Conductive plates on both sides of the wafer are the capacitor plates. The production machinery which manufactures the wafers also makes the capacitors. In B, the two sets of interlocking fingers of conductors make up the two "plates" of the capacitor; only one side of the wafer is used. This second type has a smaller capacity.

Each wafer can have the following number of components: one (seven-pin or nine-pin) tube socket, one or two inductors, one to four capacitors, and one to four resistors (Fig. 4-16). The spacing between wafers is 3/16". Wafers fit into a square hole in the board and the vertical wires connect to the printed wiring.

The original components of Project Tinkertoy have been improved and new components have been developed. Carbon resistors with greater uniformity are mounted on tape for mechanized operations. Their range is from five ohms to ten megohms with tolerances of 20%, 10% and 5%. Rating is ½ watt with higher power available by

*Registered Trade-Mark, A. G. Spaulding and Sons, Inc., (the childrens game). Commonly used to describe the modular construction developed by the National Bureau of Standards.

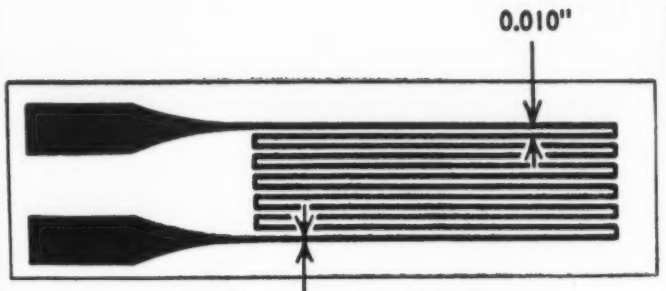


Fig. 4-17. Printed strain gage (Drawing courtesy Technograph Inc.)

parallel resistors. A cracked-carbon resistor with a tolerance of ½% is being developed. A square tube socket was developed by Amphenol for this application.

Three types of capacitors are available. Printed capacitors (using the ceramic base as the dielectric) have a range from 5 $\mu\mu$f to 0.01 μf. These capacitors have a marked temperature coefficient. Glass-dielectric capacitors have been developed with a very high Q. In 300-volt ratings the glass capacitors go from 10 $\mu\mu$f to 0.01 μf; at 500-volt ratings they go up to 0.0085 μf. The temperature coefficient is 150 parts per million per C° and they may be used up to 150°C. Mylar dielectric capacitors are available from 2500$\mu\mu$f to 0.5 μf for 200-volt operation. Higher voltages are obtainable at somewhat lower values of capacity. Units with Mylar dielectric are comparable to mica units in both Q and temperature coefficient. A more complete list of available modular components and their characteristics also is available.*

Additional Printed Components

Strain Gages

A copper-foil coil, produced on a thin base, can be used as a strain gage (Fig. 4-17). In this application the printed circuit is similar to a large metal heat sink and heavy currents can be carried. The gage is a copper-foil pattern which is attached to the body to be tested. Only the thin insulation separates the two. Strains in the metallic body change the resistance in the copper gage. Current flow, in inverse proportion to the resistance change, serves as a measure of strain. Power as high as 400 watts per square inch** has been obtained without overheating the printed circuit; resistance ranges are from 35 ohms to over 5000 ohms.

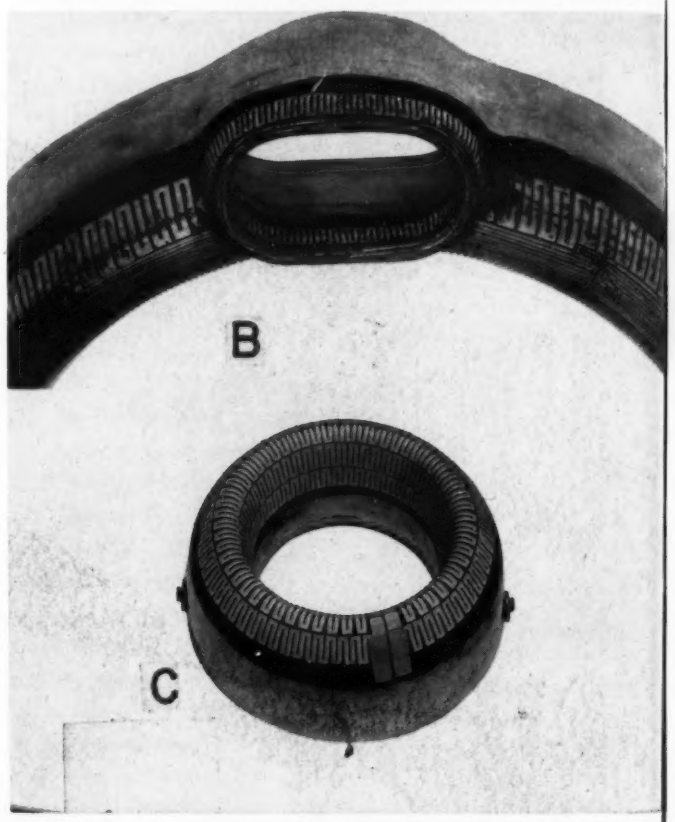
These gages have been made from a rolled copper-nickel alloy with a very low temperature coefficient of resistance. The insulator is an epoxy-resin varnish. Gages of this type are simple to use and have many applications.

Aircraft De-icing Pads

Printed wiring with a thin dielectric base has been successfully used for de-icing surfaces*** of aircraft (Fig. 4-18). Here special problems of weathering, vibration,

*ACF Electronics, Aerovox.
**Printed Circuits, P. Eisler, *British IRE*, Vol. XIII, No. 11, Nov., 1953.
***Printed-Foil Electronic Components, H. L. Shortt and P. Eisler, *Tele-Tech*, June, 1955.

Fig. 4-18. A shows assembly of de-icing mats on the tail plane assembly of Bristol Britannia aircraft. B shows sections of Rolls Royce Dart power-plant intake. C shows Vickers Viscount supercharger intake. (Photos courtesy Bristol Aeroplane Co., Ltd.)



high current, and the vital importance of their function require careful design and construction. These de-icing mats require a large area of a very thin conductor on a flexible and tough insulation which can be firmly bonded to the aircraft structure.

Additional chapters include:

UHF Applications (*in next issue*)
Circuitry, including packages
Production, including automation
Servicing

White Noise Tests Components

AIRCRAFT AND MISSILE manufacturers have determined that many failures of electronic and electro-mechanical components and assemblies are due to the high noise intensity levels generated by jet and rocket engines. Consequently, airframe manufacturers such as Convair, Boeing and Bell have included *white noise* test requirements in specifications for components used in their end units, and it appears that white-noise testing can become a standard requirement of all military agencies. ("White" noise is noise having a normal or Gaussian distribution of amplitudes.)

White noise test equipment. Exponential horn concentrates energy into 64 sq-in area.

To meet this demand for testing, Rototest Laboratories, Inc., of Lynwood, California, has established a white-noise testing facility on the West Coast. Equipment can subject a test specimen to sound pressure levels of 150 db (relative to $2x10^{-4}$ dyne/cm^2) over the frequency range from 50 cps to 10 kc. Cross-sectional area over which this level is generated is 64 square inches with level falling off 3 db for every doubling of area. An audio supply generates 215 kw and drivers are horn coupled to test chamber, which is in turn horn coupled to an absorptive termination.

For information on Rototest White Noise Testing Facility circle **206** on inquiry card.

FOR MORE INFORMATION ON ANY OF THE PRODUCTS REPORTED OR ADVERTISED IN THIS ISSUE, CIRCLE THE ITEM NUMBER ON THE INQUIRY CARD BOUND IN THE FRONT OR BACK OF THIS ISSUE. IF THE CARDS HAVE ALREADY BEEN USED, MARK THE ITEM NUMBER AND DATE OF THIS ISSUE ON A POSTAL CARD AND MAIL IN CARE OF OUR READER SERVICE DEPT.

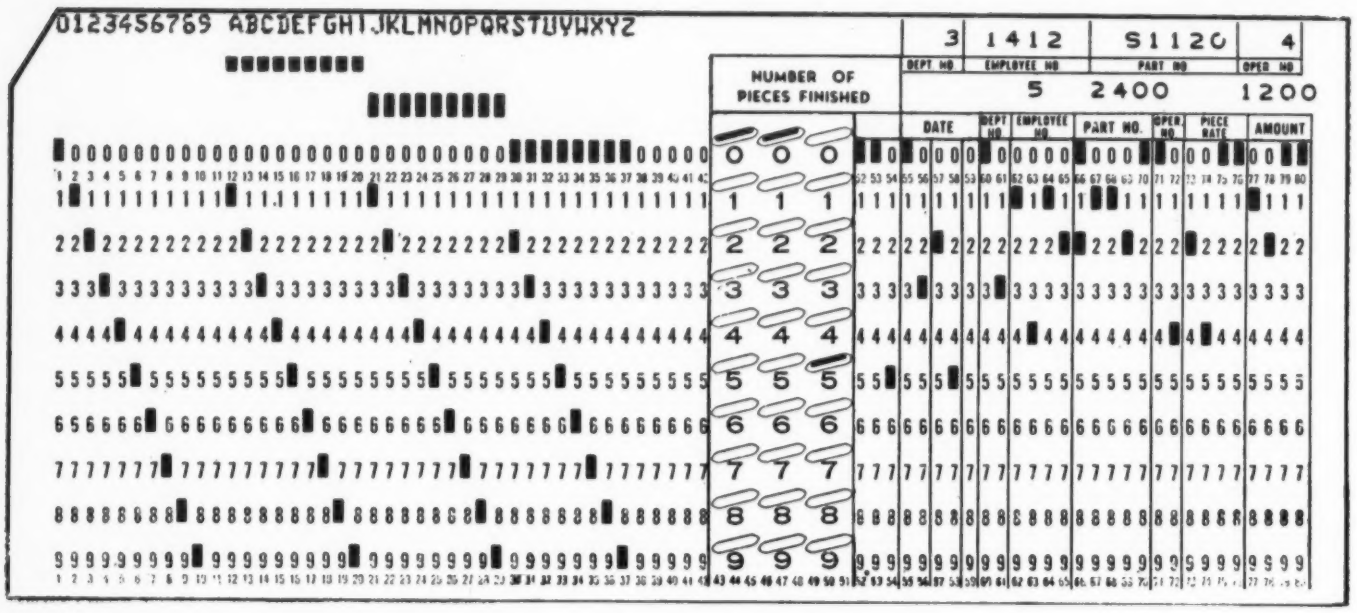
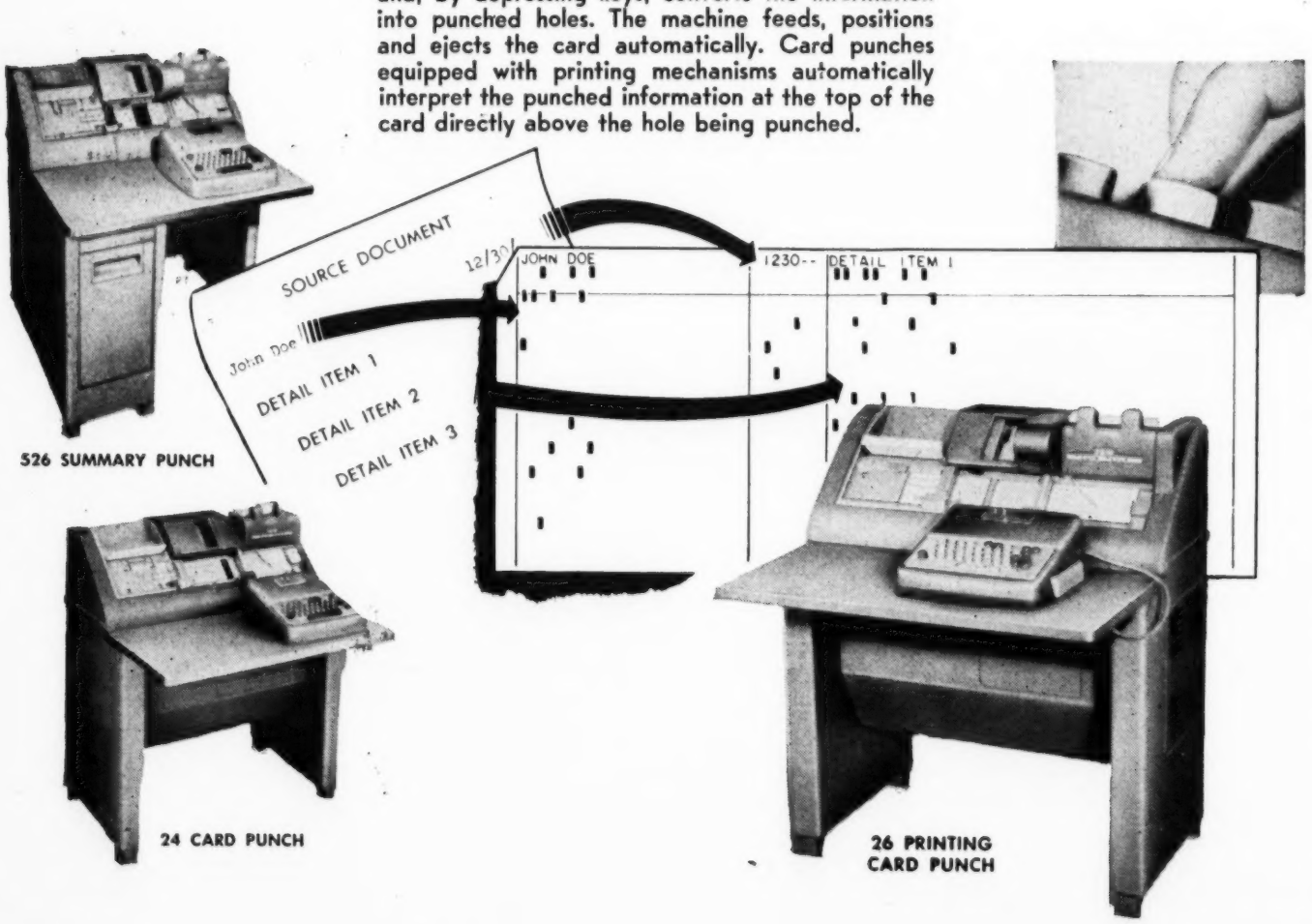


Fig. 1. The IBM card has 80 vertical columns (numbered at the bottom). Each column accommodates a hole (or holes) representing the single number or letter typed at the top of each column. For example, the letter S is represented by the punches 0 and 2, as shown in column 30.

Electronic Data-processing Machines

Fig. 2. The operator reads the source document and, by depressing keys, converts the information into punched holes. The machine feeds, positions and ejects the card automatically. Card punches equipped with printing mechanisms automatically interpret the punched information at the top of the card directly above the hole being punched.



MANY MACHINES have been invented to help with arithmetic and printing, most of which were operated individually by a person pushing levers or keys. With the development of the punched card (around the beginning of this century) the first step in automatic operation of machines for office and engineering data-processing became possible. Once information was punched into a card, two important results were accomplished—(1) a permanent record was available, and (2) the cards could be used to carry information from one machine to another, and to allow automatic control of the machines during the processing of the information.

The Punched Card

The punched card (Fig. 1) is usually the first step in automatic processing of data.

At the right of the card in Fig. 1 is shown a typical application. This card with the information shown can be used in payroll, production costs, inventory, and other applications.

Card punching is the basic method of entering source data into the punched cards. Typical card punches are shown in Fig. 2.

Verification

Verification of initial data is extremely important. Usually the best time to verify information is immediately after it has been punched into cards. A typical card verifier is shown in Fig. 3.

The "giant" computers, large electronic data processing systems, are usually built by joining groups of single- and multi-function equipments. Here is a survey of a full line of EDPM's, from small punches and verifiers to giant computers.

GEORGE TRUMAN HUNTER
and
GRAHAM M. CLARK
International Business Machines Corp.

Verification becomes increasingly important as data-processing machines become faster. For example, if you furnish wrong information to a giant computer, it will produce thousands of wrong answers in a second.

Duplication

The use of the machines to automatically copy information in cards is called duplication. Duplication is automatic punching of repetitive information from a master card into a group of succeeding detail cards. It is normally performed as part of the card-punching function on the card punches shown in Fig. 2. Instead of depressing keys repetitively for common information (such as ENTRY DATE, which is to be punched in every card), the operator punches the common information only once in the first card, and it is automatically punched into all remaining cards for the group. Automatic duplication reduces the work per card, insures consistency of common data, and increases productivity of the operator.

Gang punching (Fig. 4) is duplication in which punched information from a master card is copied into one or more detail cards that follow it.

Reproducing is a form of duplication in which information from one set of punched source cards is automatically punched into another set of cards. The two sets of cards are fed through the machine synchronously. The machines used for reproducing also are shown in Fig. 4 (except # 526).

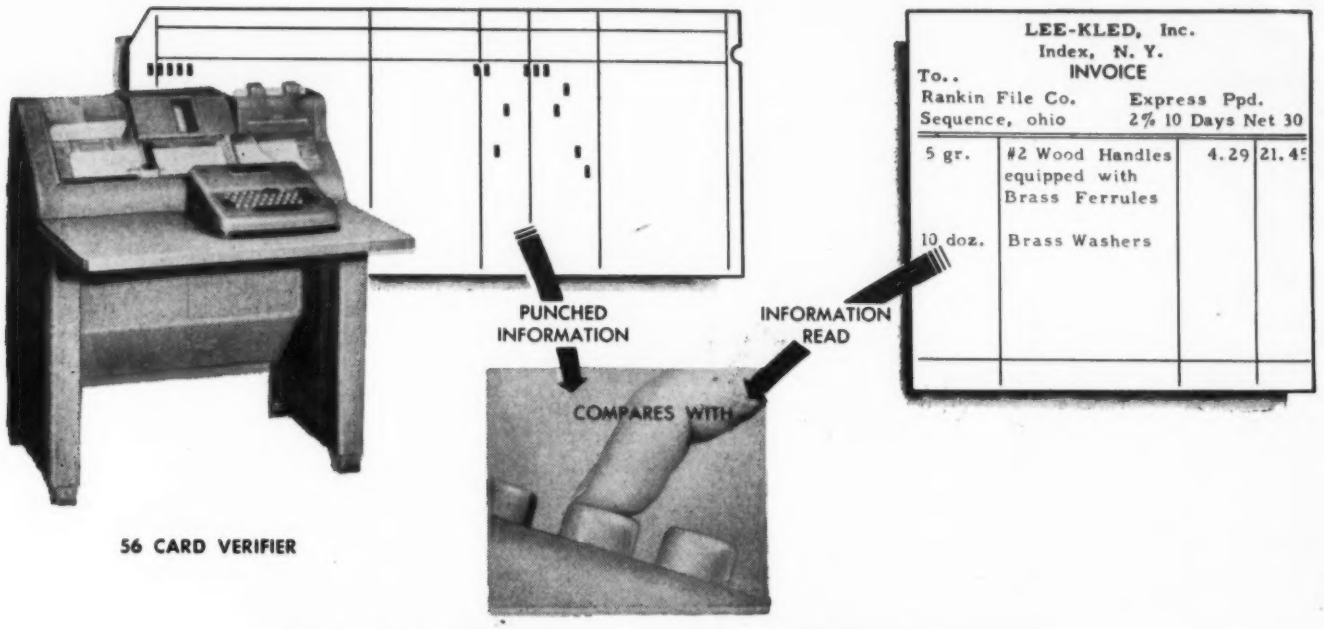
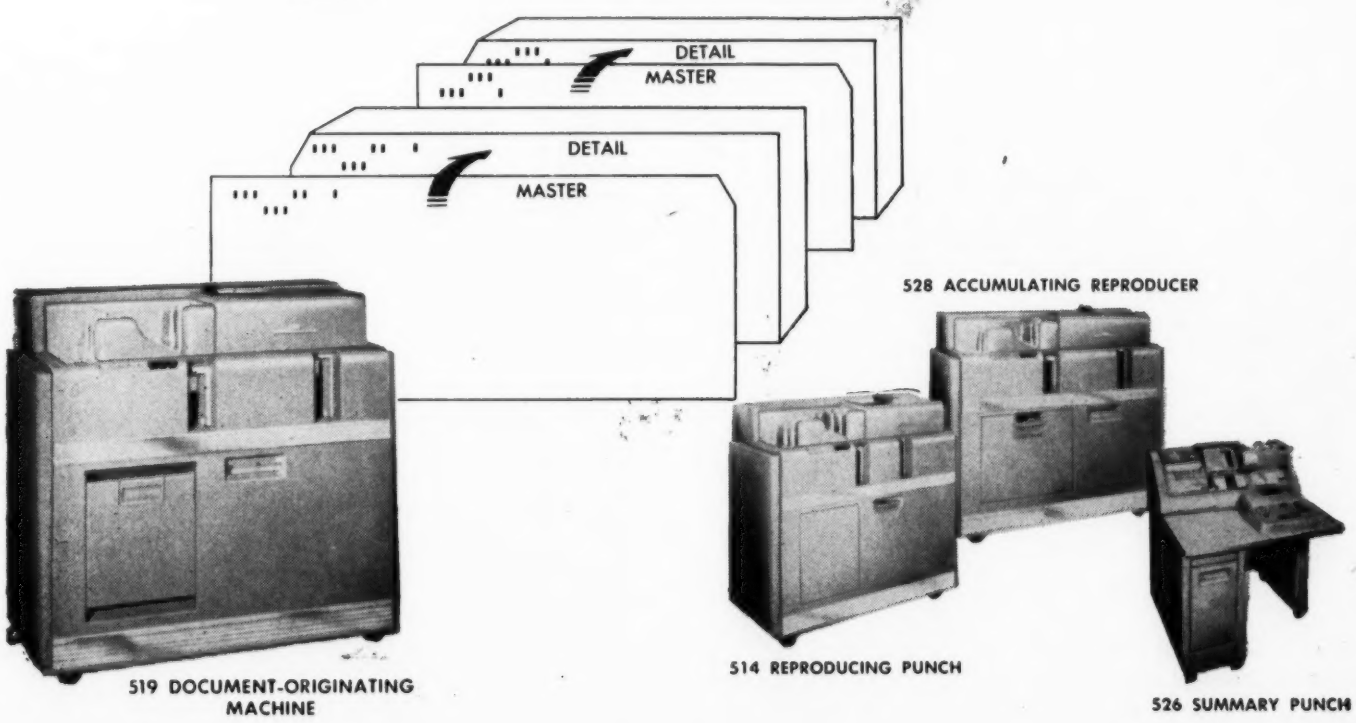


Fig. 3. Card verifying is simply a means of checking the accuracy of the original key punching by depressing the keys of a verifier while reading from the same source data. The machine compares the key depressed with the hole already punched in the card. A difference causes the machine to stop, indicating a discrepancy. A notch in the upper right edge of the card indicates that it has been key punched and verified correctly. A notch directly above a column signifies that the punching of that column does not agree with the key depressed for verification.

Fig. 4. Where information changes from one group of cards to the next, interspersed gang-punching methods can be used. A master card precedes each group of detail cards. Information in the master card is automatically selected for punching into all following detail cards until a new master is read. The punching pattern then changes to conform with the new master. Gang punching can be performed separately or in combination with reproducing and summary punching for both alphabetical and numerical information. It should be noted here that the cards now contain both data to be copied and information, also in the form of punched holes, for control of the machine.



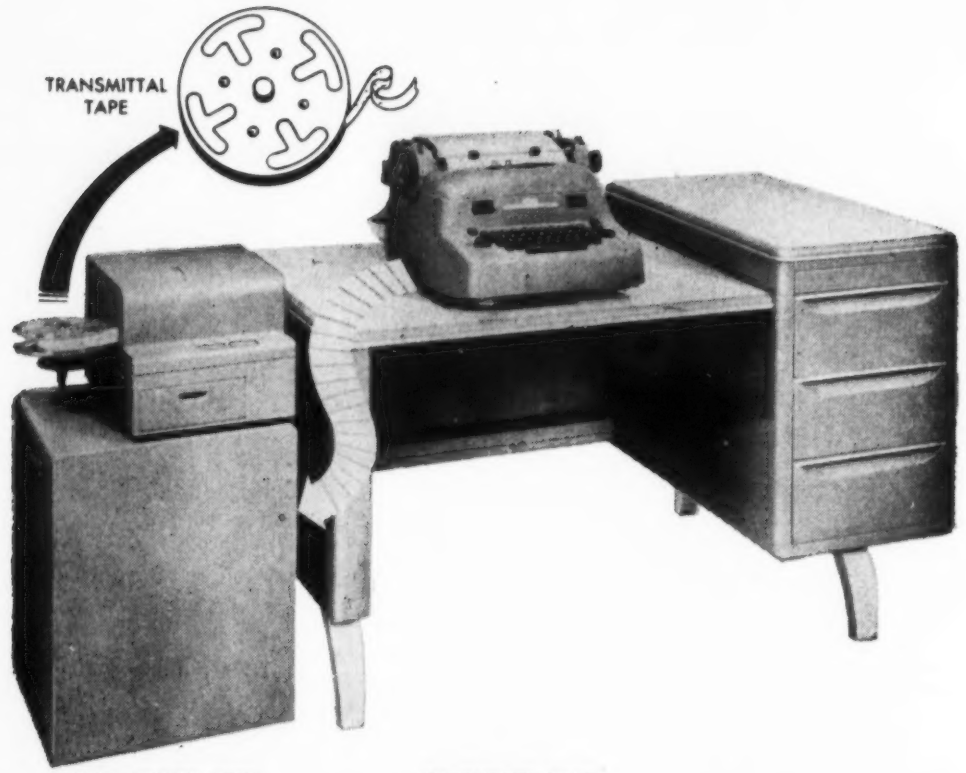


Fig. 5. Electric typewriter and tape punch unit comprise the 884 Typewriter Tape Punch, which puts coded information on 8-channel or 5-channel punched-paper tape. Special electric typewriter connected to Type 24 or 26 card punch (Fig. 2) simultaneously types document and puts same information into punched cards.

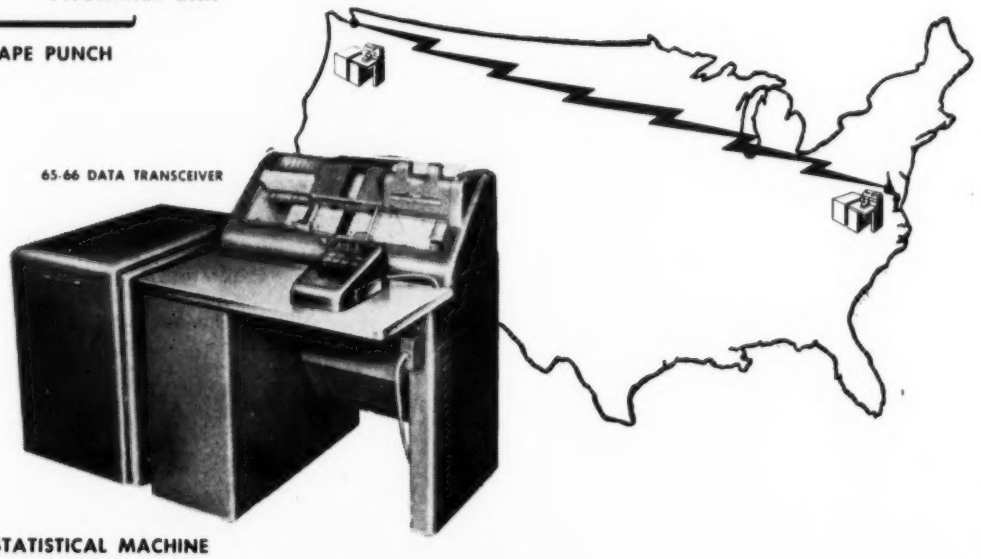


Fig. 6. Data transceiver accepts punched-card data and reproduces card at remote location by telephone or telegraph. Machines at either end are identical. Transceivers are vital link in CONUS—DTSN, Army Signal Corp. supply system (discussed in March-April MA).

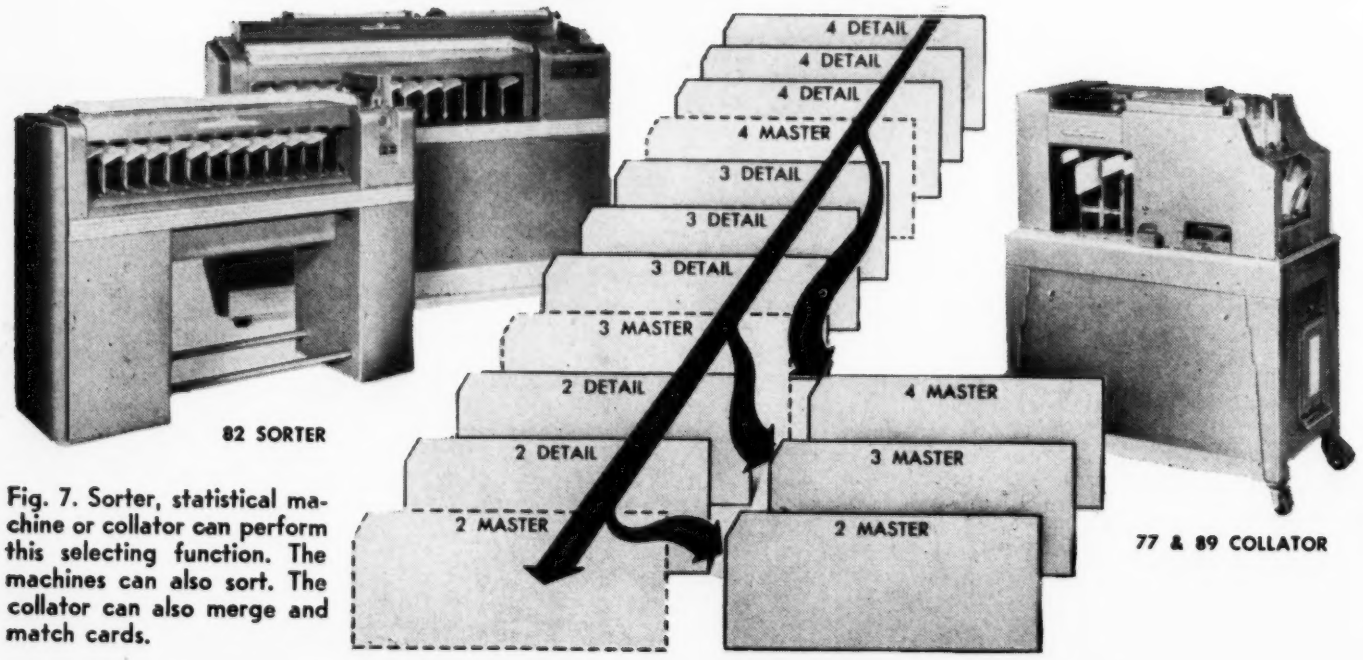


Fig. 7. Sorter, statistical machine or collator can perform this selecting function. The machines can also sort. The collator can also merge and match cards.

Mark-Sensed Punching

Mark-sensed punching is illustrated in Fig. 1. A machine reads pencil marks on a card and converts these into punched holes. The three columns in the center of the card show pencil marks for the value 005. The corresponding punches are shown in columns 52, 53, and 54, having been punched there by one of the machines in Fig. 4 (except the 526). This type of operation has been proven in many applications during the past 20 years. The original facts may be recorded anywhere—office, plant, or field, by workmen, timekeepers, or field workers—and those facts are translated directly into punched hole form. This type of marking has been used for grading multiple-choice and true-false tests by means of IBM test-scoring machine.

Typewriter Card and Tape Punching

Typewriter card punching is the simultaneous action of creating a document in a typewriter and putting part or all of the same information into punched cards. This machine consists of a special IBM electric typewriter connected to a Type 24 or 26 card punch.

Typewriter tape punching is the simultaneous action of creating a document in a typewriter and putting part or all of the same information into an 8-channel punched paper tape (Fig. 5). The tape can be easily transported to other locations and processed through a tape-to-card punch (Type 46 or 47) to transfer the information into punched cards.

Tape Reading

Tape reading is a process of feeding punched paper tapes through a tape-to-card punch to convert the coded data onto punched cards. Tapes can be prepared on the typewriter tape punch or on the card-controlled tape punch; the latter is capable of punching tape that can be transmitted by telegraph.

Interpreting

Interpreting is the translation of punched holes into printed information on an IBM card.

Alphabetic or numerical information can be printed in many different positions on the same card from which it is read. Common data can be repetitively printed on a group of detail cards from punched information on a master card.

End Printing

End printing is the conversion of punched information into bold printing across the end of the card simultaneously with gang punching, summary punching, reproducing, and mark-sensed punching (all functions of the 519 Document Originating Machine shown in Fig. 4). It is similar to interpreting, and makes possible quick reference to the card.

Sorting, Selecting, Merging, Matching

After cards have been punched it is usually necessary to arrange or rearrange their sequence, select certain cards, or add additional cards before actually processing them for arithmetic operations. This type of data processing can be done automatically by several different machines.

Sorting is the process of grouping cards in numerical or alphabetical sequences according to any classification punched in them. To group cards by account, for instance, they are sorted into account sequence. It is then possible to summarize the cards by account.

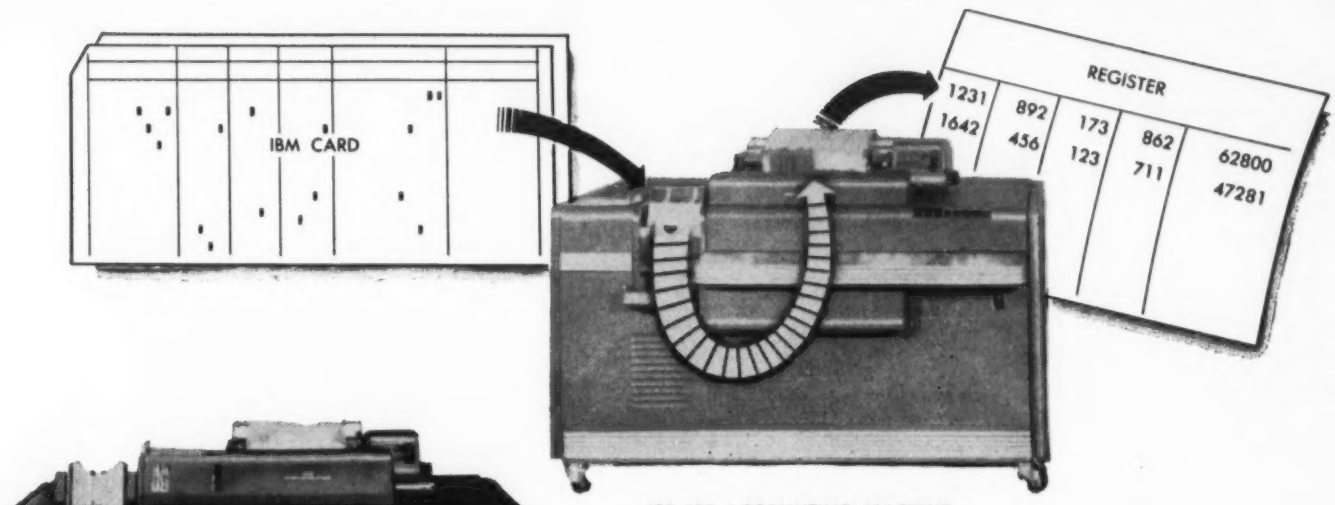
Fast, automatic machines (Fig. 7) are provided for arranging cards for the preparation of reports originating from the same cards, but each requiring a different sequence or grouping of information.

Selecting is the function of pulling from a mass of data, certain items that require special attention. Selection of individual cards is accomplished automatically by either the sorter or collator (Fig. 7) according to the type of selection. Typical selections are: (1) cards punched with specific digits, (2) certain type of cards for a specific date, (3) all cards containing a specific number, (4) all cards higher than a specific number, (5) all cards lower than a specific number, (6) cards between two specific numbers, (7) first card of each group, (8) last card of each group, (9) unmatched cards, (10) cards out of sequence.

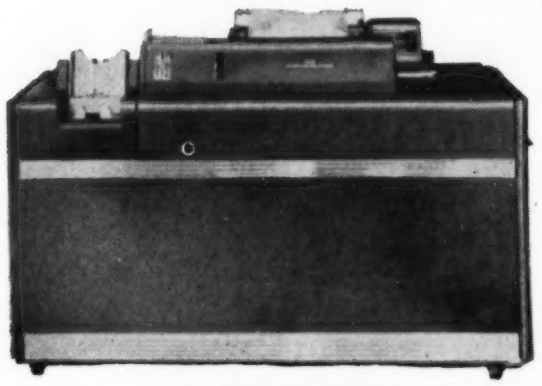
Merging is the term for combining two sets of punched cards into one set of given sequence. Both files of cards must be in the same sequence before they are merged. This function makes possible automatic filing of the new cards into an existing file of cards. It is a faster method than sorting for placing related cards together. Merging is performed automatically in a collator.

Matching is the term for a checking function used to check the agreement between two sets of cards. Groups of cards in one file are compared with similar groups in a second file. Unmatched cards or groups of cards in either file may be selected or separated from the files. This function is frequently performed in conjunction with merging in the collator (Fig. 7).

As a collator has two card feeds and four selecting pockets, the functions of merging, matching, sequence checking, and selecting may be formed in many different combinations. After the cards are properly arranged they are ready for processing by a variety of machines.



402-403 ACCOUNTING MACHINE



407 ACCOUNTING MACHINE

Fig. 8. Accounting machines add, subtract, cross-add, totalize, etc., and print out the information as the cards pass through the machine. Reports can be printed at a rate of 150 lines per minute. Machines can position forms to print data in desired locations.

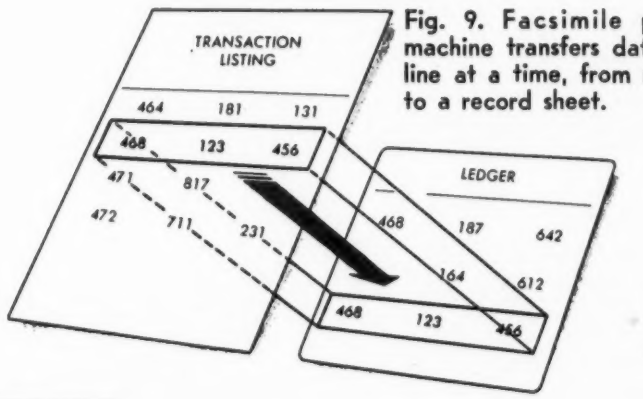


Fig. 9. Facsimile posting machine transfers data, one line at a time, from reports to a record sheet.

Detail and Group Printing by Accounting Machines

Detail printing is printing information from each card as the card passes through the machine. The function is used to prepare reports that show complete details about each transaction. During this listing operation the machine can add, subtract, cross-add or cross-subtract and print many combinations of totals. These operations are performed by the machines in Fig. 8.

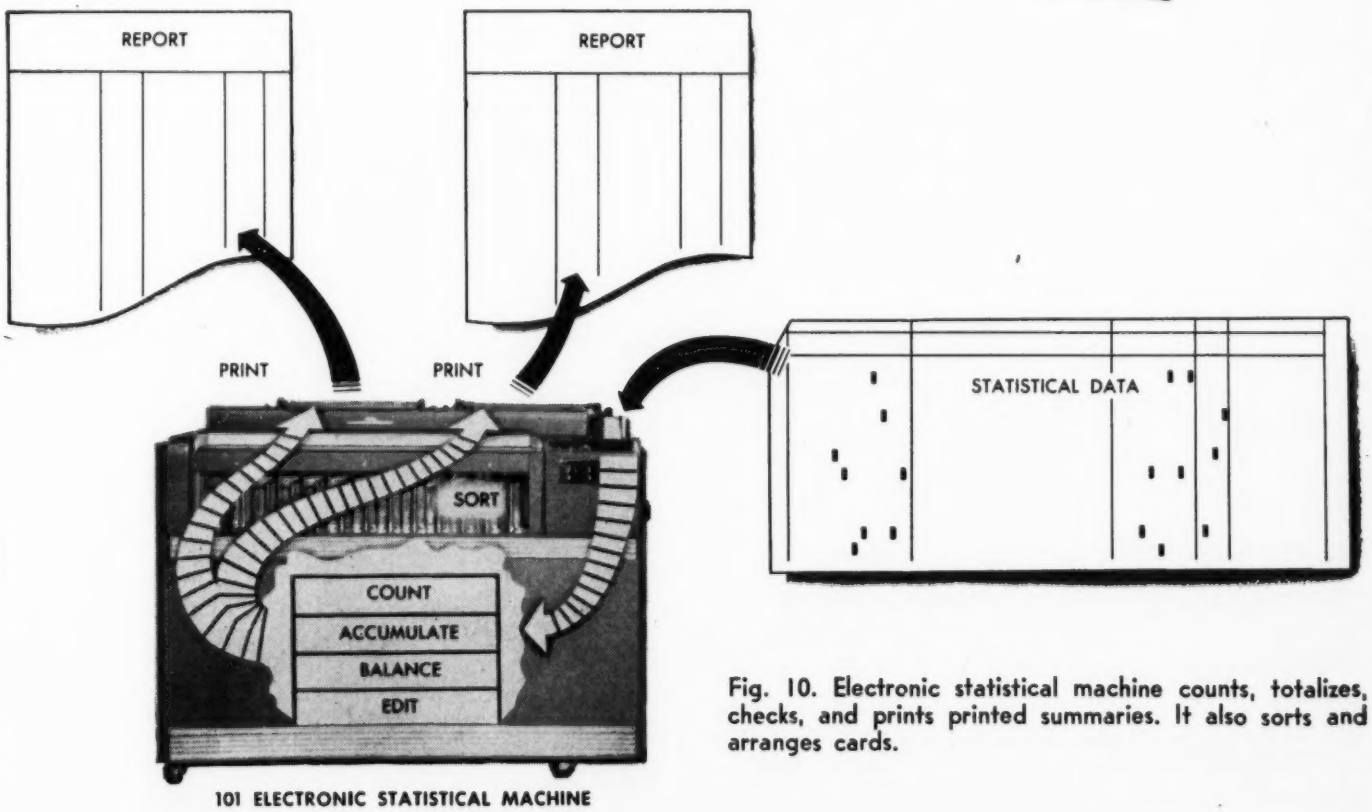
Group printing is an accounting-machine function that summarizes groups of cards and prints the totals on a report. Totals can involve adding, subtracting, etc.

Summary Punching

Summary punching is the term for automatic conversion into punched-hole form of information developed by the accounting machine. Summary punching is used for the following purposes:

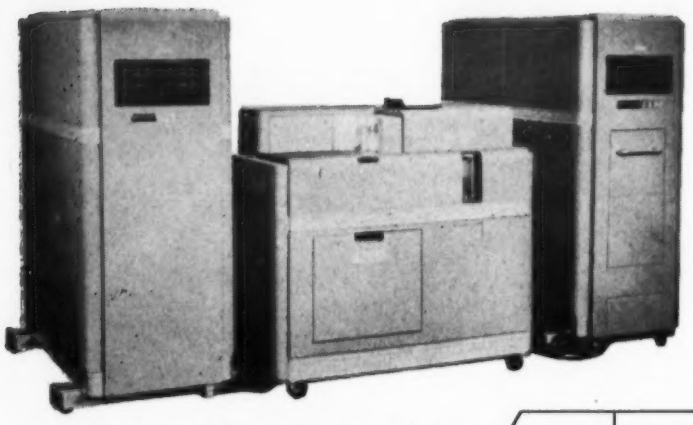
1. To carry balances forward.
2. To reduce card volume and carry summary data.

Summary data also can be fed, by cable, to the Summary Punch Machine shown in Fig. 2. Summary punching also can be performed by the 519 Document-Originating Machine shown in Fig. 4.

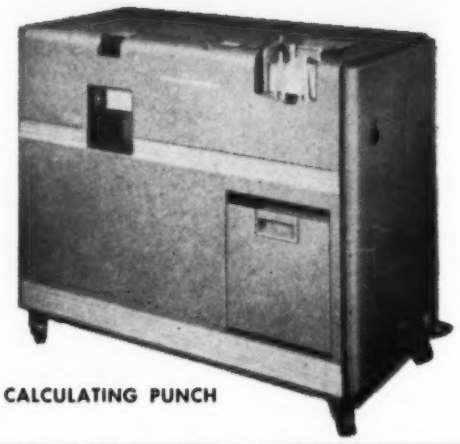


101 ELECTRONIC STATISTICAL MACHINE

Fig. 10. Electronic statistical machine counts, totalizes, checks, and prints printed summaries. It also sorts and arranges cards.

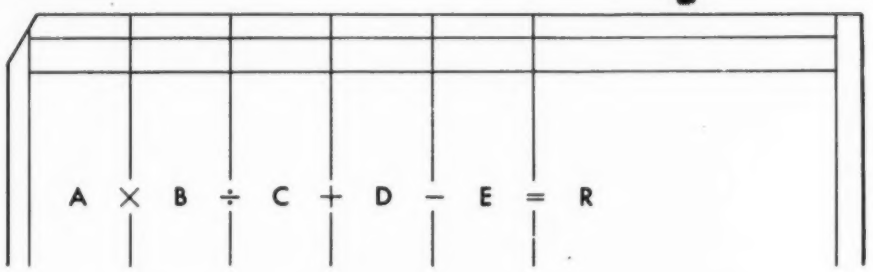


607 ELECTRONIC CALCULATING PUNCH
(604 IS SIMILAR)



602A CALCULATING PUNCH

Fig. 11. Typical small automatic digital calculators.



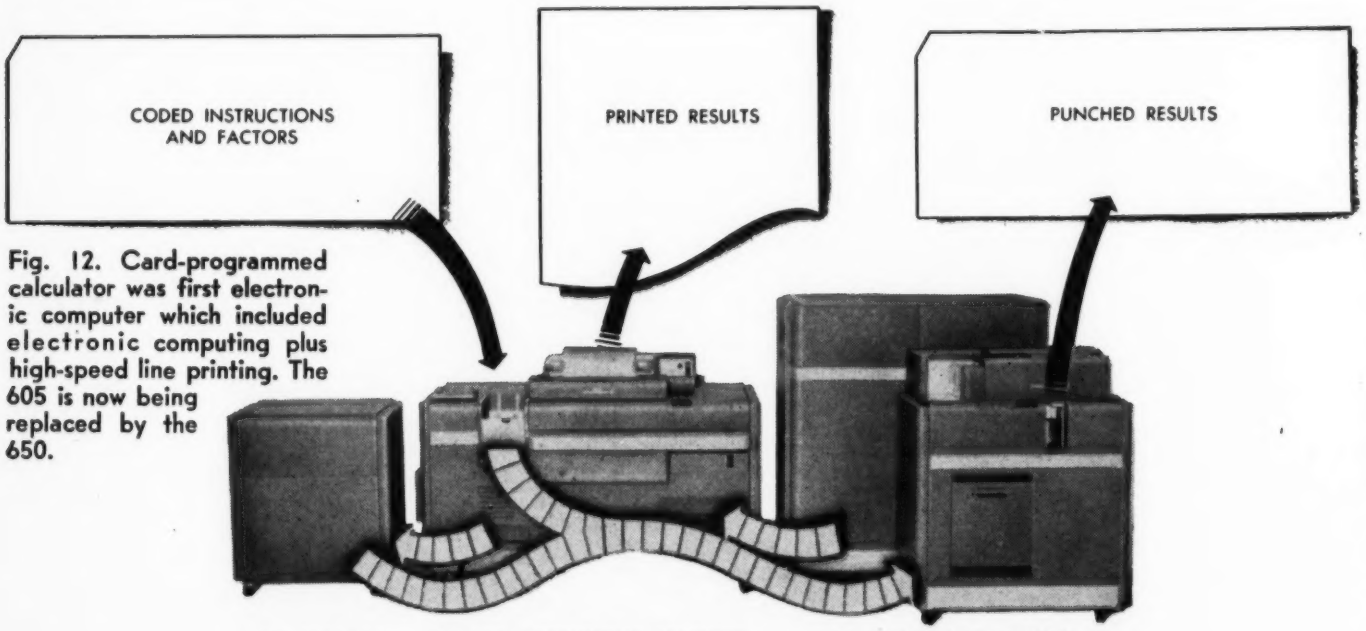


Fig. 12. Card-programmed calculator was first electronic computer which included electronic computing plus high-speed line printing. The 605 is now being replaced by the 650.

Fig. 13. New 305 RAMAC Random Access Memory Accounting Machine) is a complete, compact data processing machine built around a disk memory unit (visible in background) having a storage capacity of 5,000,000 digits. This unit consists of 50 magnetic metal disks arranged in a vertical stack, with data recorded on or read from each side of the disks.

Statistical Machines

Many problems in statistics are handled well by the statistical machine shown in Fig. 10.

Statistical work is essentially a problem of counting units in many different classifications. At the same time it is frequently desirable to accumulate certain quantities or amounts, check or edit for consistency or reasonableness, and balance counts to the control totals to check the accuracy of the summaries. All of these functions are performed by the Electronic Statistical Machine to produce printed summaries. This machine also performs sorting and card-arranging operations.

The first large-scale use of these machines was for processing a great deal of the United States 1950 census data. Since that time they have been used in census operations in many other countries. They are also used in searching card files of books or reference articles, chemical and physical characteristics of substances, police records, and other applications.

Small Digital Calculators

During the 1940's there arose an increasing demand for machines which could do more complicated arithmetic for accounting problems. Even payroll calculations, which are usually thought of as being simple, sometimes require many steps of arithmetic to calculate gross pay, many deductions, net pay, and new year to date values. Also during those years more interest was shown for the use of automatic calculating machines in the fields of scientific computation. The result of the interest shown in these two fields led to the large-scale production of electromechanical and electronic calculators. Typical examples of these machines are shown in Fig. 11.

The widespread acceptance of these machines is indicated by the fact that from 1948 through 1956 more than 3000 IBM Type 604 electronic calculating punches were installed in business offices in the United States. Each of these machines contains over 1300 electronic tubes. Each machine reads and punches cards at the rate of 100 cards per minute and, for each card, up to 60 individual steps of arithmetic can be performed. Typical business applications of these small electronic calculators include: Payroll calculations, interest calculations, insurance premium calculations, discounts, invoice calculations, agents and brokers discounts and commissions, and actuarial tables.

These calculators are used also to solve scientific and engineering calculations such as: formula evaluation, numerical differentiation and integration, solution of simultaneous equations, curve fitting, solution of differential equations, correlation and regression analysis, and matrix manipulations.

A slightly larger and much more capable computer than those previously described is the Card-Programmed Calculator (Fig. 12).

Card-Programmed Calculator

The CPC is actually composed of several machines which are connected together by electrical cables. The Accounting Machine reads from the punched cards the data to be calculated and the codes that instruct the machines what calculation to perform. The data can be

held in storage devices in the various machines. The storage unit increases the capacity of the entire machine so that it can handle larger problems.

The calculations are performed at high speed in the electronic calculator (the 605 Calculating Punch or 650). Upon completion of the calculations, results can be printed in report form by the high-speed line-printer part of the accounting machine, as well as punched into cards by the punch unit.

This machine is used in the preparation of payrolls, general ledger accounting, actuarial studies, statistics, and other business calculations. The majority of these machines are used for engineering and scientific calculations, including: cam design, transformer design, fourier harmonic analysis, engine performance, airplane landing gear dynamic analysis, interior and exterior ballistics, stability of feedback systems, lens design, etc.

Intermediate-Capacity Stored-Program Machine

The next IBM machine is the intermediate-capacity stored-program machine, the IBM Type 650 Magnetic Drum Data-Processing Machine (Fig. 14).

The input of both data and instructions is in the form of punched cards. The magnetic drum stores data as well as instructions. Computing and control circuits are electronic. The computed results are punched into cards which may be used to print results in IBM accounting machines. The internal-logic self-checking features, convenient operator's console, and compatible IBM card input and output make this machine flexible and efficient.

Large-Scale Data-Processing Machines

The final category of IBM machines is one comprising the large-scale electronic data-processing machines. The machines in this class are divided into two groups: The "IBM 701, 704 and 709" are designed for engineering and research calculating, and the "IBM 702 and 705" are designed for accounting and record-keeping applications.

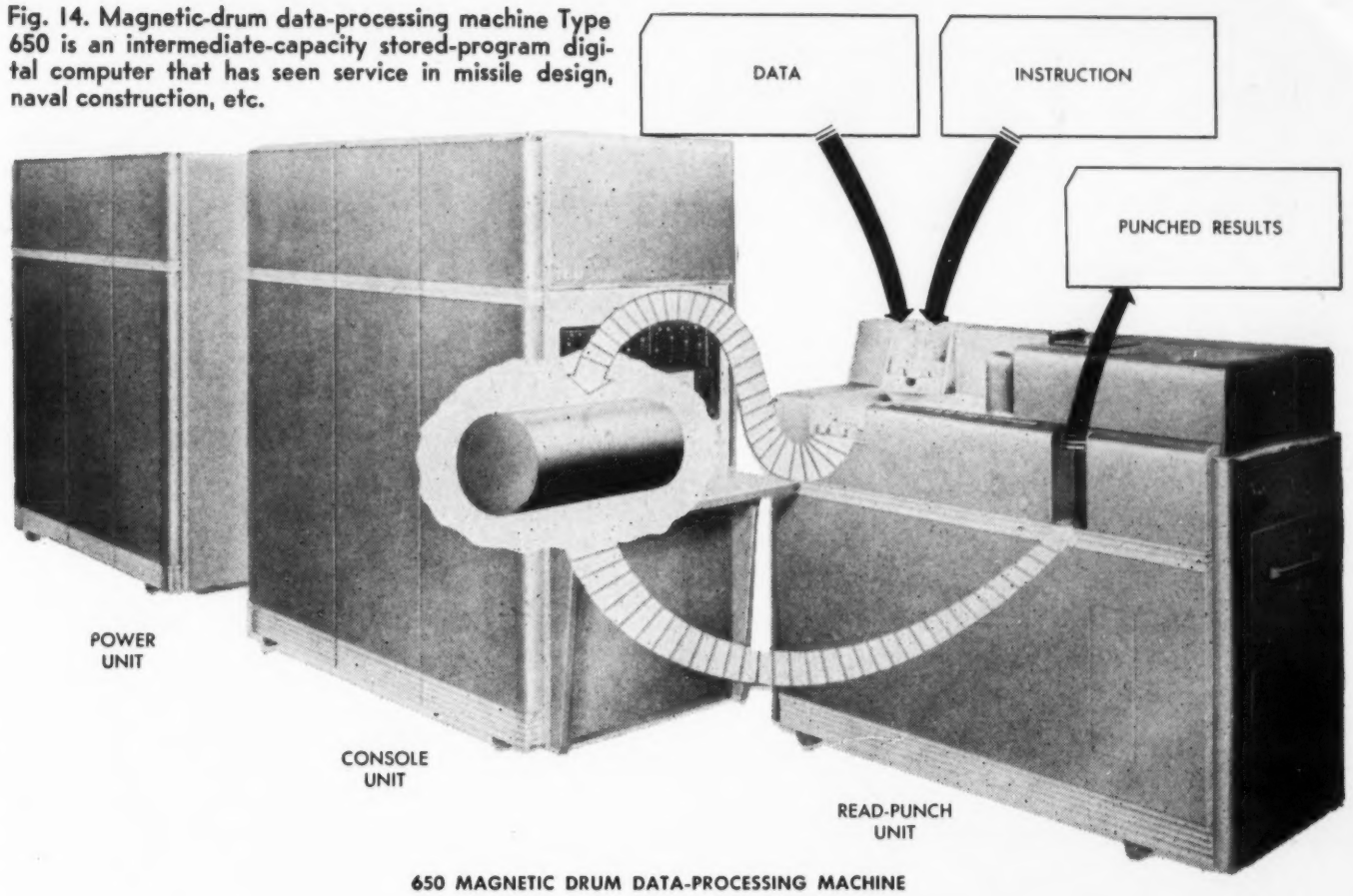
One of the biggest calculators ever constructed is the NORC (Naval Ordnance Research Calculator) built by IBM for the Navy's Bureau of Ordnance. The NORC is shown in Fig. 15. Facts concerning its operation are in Table 1.

Conclusion

As has been described, electronic data-processing machines (EDPM) range from a simple card punch to powerful electronic calculators.

There is nothing particularly profound or high-brow in the application of the concept of automation in the field of data processing. A person needs some general knowledge of the capabilities of data-processing systems, an introduction to which has been given. He also needs some imagination, an open mind, and the willingness to adopt new procedures when such a change promises to be advantageous.

Fig. 14. Magnetic-drum data-processing machine Type 650 is an intermediate-capacity stored-program digital computer that has seen service in missile design, naval construction, etc.



650 MAGNETIC DRUM DATA-PROCESSING MACHINE

Table 1.—Development of Storage Capacity and Addition Time of Data-Processing Machines

Calculator	*Date*	*Storage Capacity (Digits)*	*Addition Time (Microseconds)*
Automatic Sequence Controlled Calculator	1944	3,000	300,000
Selective Sequence Electronic Calculator	1948	400,000	20,000
701	1952	8,000,000	60
Research Calculator Naval Ordnace	1954	50,000,000	14

Fig. 15. NORC, one of the largest calculators ever constructed and in operation.

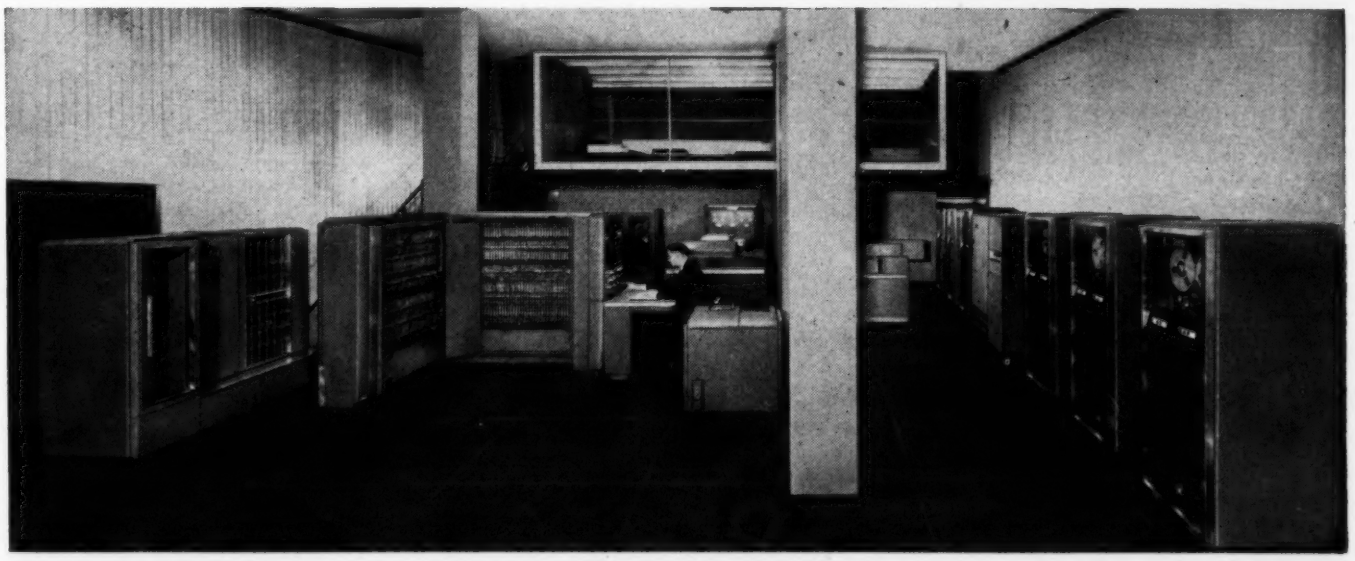


Fig. 16. The Types 704 and 709 are IBM's most powerful computer. Magnetic tapes record 200 characters per inch.

New Product Preview

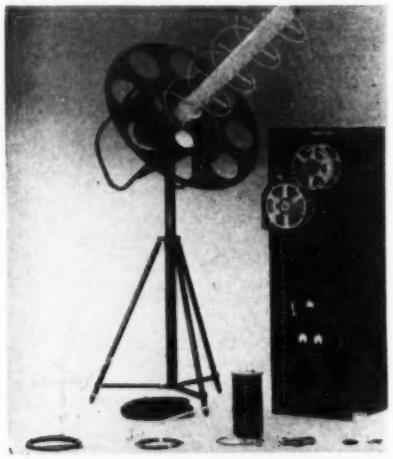
COW Palace visitors are assured of a record WESCON Show, August 20-23, if the number and variety of products announced by manufacturers for first showing is an indication. Those items shown below provide the exhibitor's booth numbers available at time of printing. Other new items, not released as Wescon features, begin on page 234. The Instruments Publishing Company representatives will greet you in booth 615 with copies of INSTRUMENTS and AUTOMATION, INSTRUMENT & APPARATUS NEWS and MILITARY AUTOMATION for your inspection.

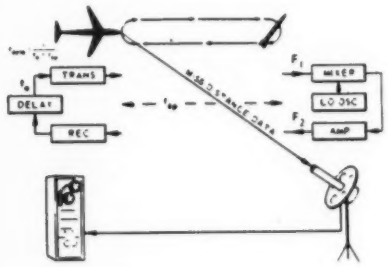
ELECTRONIC MDI

PARAMI (Parsons Active Ring-around Miss Indicator) is a system for electronically measuring the separation between a target and missile in space. Its radial range is from 10 to 3000 feet at line-of-sight distances to 100 miles. A permanent time-history record of distance is produced at a remote recording ground station from which the closest approach of intecept can be established in less than fifteen seconds.

Specific advantages of PARAMI system are said to include high order of reading sensitivity; inherent reduction of errors; inflight system calibration; recording of ripple firings; and mobile installations for uninstrumented ranges. System is effective in training and in proof testing of missiles to verify compliance with performance specs. Booth 1330.—*The Ralph M. Parsons Co.*, 151 *South De Lacey Ave., Pasadena, Calif.*

For more information circle **303** on inquiry card.

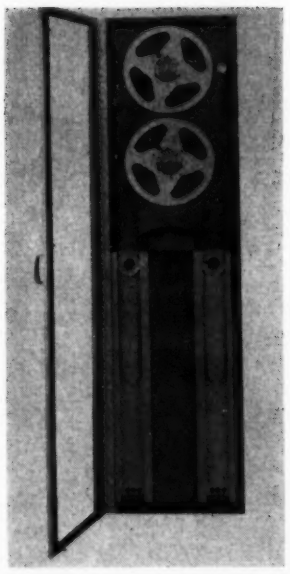




TAPE TRANSPORT

New Model 546-53368 Digital Magnetic Tape Transport selects any one of 10 closely regulated tape speeds (1.5, 2.25, 3, 4.5, 9, 15, 22.5, 30, 45, and 90 in/sec) by remote or local control. Three-quarter-inch tape is used, on two 10 1/2 inch reels. Start-stop time is 6 milliseconds. Booths 3107-8. —*ElectroData Division of Burroughs' Corp., Pasadena, Calif.*

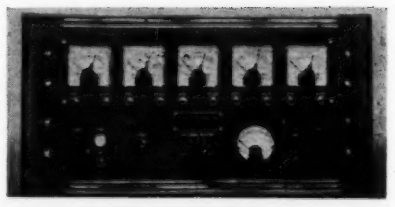
For more information circle **301** on inquiry card.



TRANSISTORIZED RADIACS

New transistorized Model 420B is remote laboratory monitor, with 25 feet of coaxial cable and built-in automatic alarm system. Can be used to monitor contamination in radioisotope laboratories, hospital clinics, reactor installations, has interchangeable probes for alpha-beta-gamma detection. An automatic visual and audible alarm system can be preset to operate at any predetermined level of radiation. Also showing other radiacs and wide range of transistorized power supplies, at booth 1206. —*Universal Atomics, A division of Universal Transistor Products Corp., 50 Bond Street, Westbury, L.I., N.Y.*

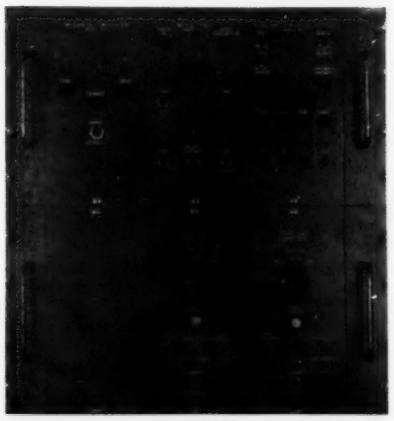
For more information circle **302** on inquiry card.



AUTOMATIC ANTENNA SELECTOR

New automatic antenna selector is said to eliminate the effects of antenna shading in aircraft by alternately monitoring communications signals from multiple antennas and automatically selecting the correct antenna to provide uninterrupted reception, even under conditions that would normally cause severe fading. Weighing only 2.5 pounds, it complies with MIL-E-5400 and MIL-T-5422C specs. Booths 2617-8.—*Autonetics Div., North American Aviation, Inc.*, 9150 *E. Imperial Highway, Downey, Calif.*

For more information circle **304** on inquiry card.



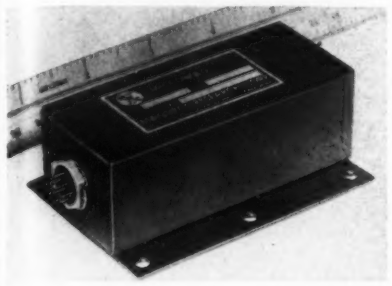
TEST SYSTEM

New Hi-Pot Impedance and Continuity Test System for all types of electronic assemblies consists of master unit, hipot and continuity tester, impedance tester and two types of slaves (scanning units). A minimum system consists of a master unit, tester and slave. Additional testers and slaves can be added as required by the type and number of circuits and tests to be performed. The system can be quickly changed to a different test setup by changing plug-in adapter harnesses. See in booth 2105. —*Cal-Tronics Corp.*, 11306 *Hindry Ave., Los Angeles* 45, *Calif.*

For more information circle **305** on inquiry card.

MAGNETIC AMPLIFIER

New Micromag MMO-528 magnetic low-level DC signal amplifier features a built-in transistor oscillator which generates its own frequency, enabling operation directly from 28 vdc aircraft or missile source. De-

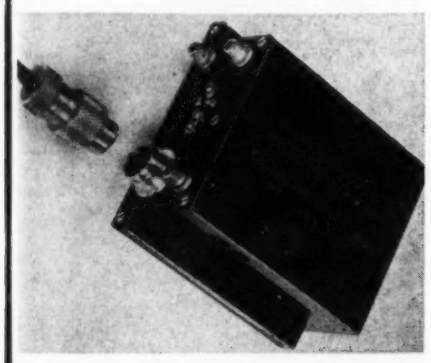


signed for amplification of signals from thermocouples, strain gages and similar transducers, the amplifier achieves 5 vdc output from 10 millivolt dc input signal, is temperature compensated from 0 to 60°C or to 85°C on request. Meets MIL-E-5272A specs. Booth 2125.—*Magnetic Research Corp., 3160 West El Segundo Blvd., Hawthorne, Calif.*

For more information circle **306** on inquiry card.

AIRBORNE AMPLIFIER

New voltage amplifier, Model F-418, for use in missiles and aircraft,



uses ruggedized subminiature tubes individually selected for low microphonics. The amplifier can be potted for special applications. Booths 1412 and 1413.—*Gulton Industries, Inc., 212 Durham Avenue, Metuchen, N. J.*

For more information circle **307** on inquiry card.

MAGNETIC AMPLIFIER

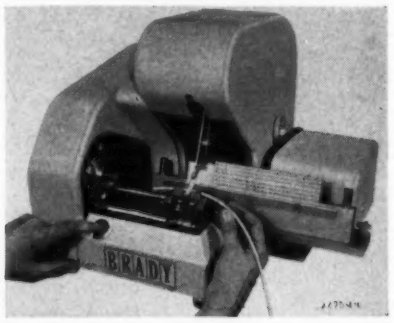
New type PA3C-1 Magnetic Amplifier is said to provide proportional temperature control of a 100-watt

heating element in response to a 1-ohm change in resistance of a temperature sensor in airborne applications. Operates in ambient temperatures of −55°C. to 100°C. and exceeds all other environmental conditions of MIL-E-5272. See in booth 707.—*Magnetic Controls Company, 6405 Cambridge St., Minneapolis 16, Minn.*

For more information circle **308** on inquiry card.

WIRE MARKER

New Mark-Matic wire marking machine applies self-sticking, Perma-Code wire markers to as many as

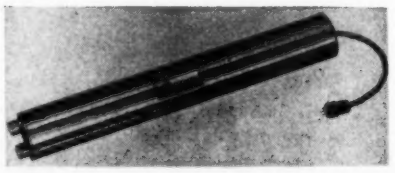


1000 wires per hour. Booth No. 1113. —*W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.*

For more information circle **309** on inquiry card.

T-W AMPLIFIERS

New permanent-magnet focused Types HA-28, HA-29, HA-30, and HA-31 will be shown in booths 503 and 504. Maker's low-level (10 mw) line now covers range from 1 to 12.4 kmc. Medium-power (1 w) amplifiers are also available in the S and X



bands. Elimination of the solenoid and its associated supply results in over 10-1 weight reduction. Focusing is by high coersive force ceramic magnets arranged in a periodic structure, enabling operation without electrical or mechanical adjustments.—*Huggins Laboratories, Inc., 711 Hamilton Ave., Menlo Park, Calif.*

For more information circle **310** on inquiry card.

LIGHT-WEIGHT TWT

New light-weight traveling wave tubes, including solenoid and permanent magnet types. Booth 2503A.—*Geisler Laboratories, P. O. Box 252, Menlo Park, Calif.*

For more information circle **311** on inquiry card.

TAPE READER

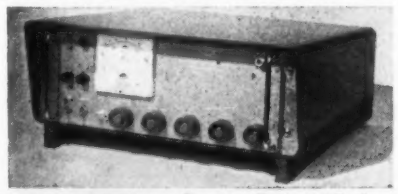
New Tape-ard Reader supplies 80 bits of information for each event without use of memory circuits by simultaneously reading a "frame" of 8 x 10 perforations in 1" tape. The

device is said to present new techniques for business machines, computers, and automatic testing equipment where tape or card programming and data storage are used. See in booths 412-13.—*California Technical Industries, 1476 Old County Road, Belmont, Calif.*

For more information circle **312** on inquiry card.

B-W OSCILLATOR

New backward-wave oscillator signal generator can be electronically swept to cover any part or all of its frequency range. The unit also has built-in square-wave modulator. Fre-



quency ranges, from .5 to 15 kmc. A completely new instrument, a Backward-wave Oscilloscope and Sweeper Unit, will also be shown. Booth 2503B. —*Wave/Particle Corp., P. O. Box 252, Menlo Park, Calif.*

For more information circle **313** on inquiry card.

SPOT WELDER

New heavy-duty spot-welding team consists of Model 1023 welding head and Model 1027 power supply. Said

to feature adjustable electrode pressures from 2 to 50 lbs, direct reading watt/second meter, and stepless heat control. Power supply with 3200-mc capacitance yields 250 watt/seconds available energy. Booths 805-806.—*Weldmatic Division, Unitek Corp., 380 N. Halsted, Pasadena, Calif.*

For more information circle **314** on inquiry card.

AC MILLIVOLTMETER

New portable, battery operated, transistorized millivoltmeter is said to make accurate ac measurements to 50 microvolts and to eliminate voltage fluctuation effects and 60 cps "beating". Twelve full-scale ranges between .001 and 300 vac are provided as well as decibel coverage between −80 and +52 dbm. Usable frequency coverage is provided between 1 cycle and 5 mc. Accuracy is ±3% between 5 cycles and 1 mc. Input Z 22 megohms. Booth 106.—*Fisher Research Laboratory, Inc.*, 1961 *University Ave., Palo Alto, Calif.*

For more information circle **315** on inquiry card.

DIFFERENTIAL AMPLIFIER

New Model DA-101 Wide-band Differential Amplifier handles low-level signals, *including pulse signals*, without noise or hum pickup. Static com-

mon-mode rejection is greater than 100,000 to 1. Gain is adjustable in steps from 100X to 2000X, with a gain accuracy of 0.1%. Linearity is ±0.05%. Booths 2815-6.—*Epsco, Inc.*, 588 *Commonwealth Ave., Boston* 15, *Mass.*

For more information circle **316** on inquiry card.

ENVIRONMENTAL CHAMBER

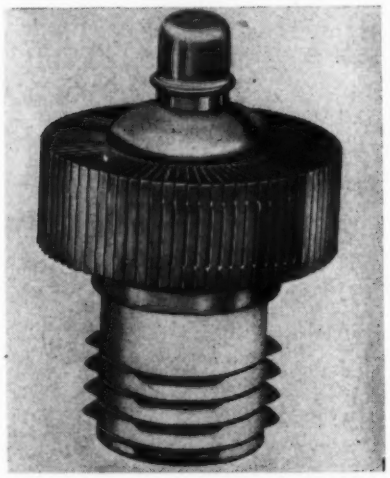
New −200°F. chamber equipped with Freon 14, 13, and 22, will be shown in booth 807 with information

on other new models of environmental chambers, such as altitude, temperature, and humidity.—*Conrad, Inc.*, 141 *Jefferson St., Holland, Mich.*

For more information circle **317** on inquiry card.

1 KW CERAMIC TETRODE

New Eimac 4CX10000A ceramic radial beam power tetrode rated at

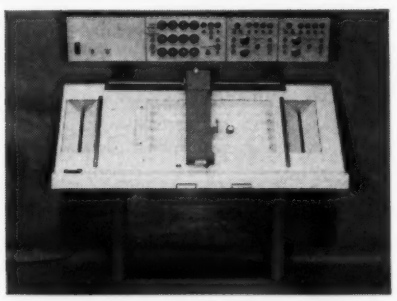


1000 watts plate dissipation and designed for single sideband operation. Booths 1706, 1727-28.—*Eitel-McCulloughs, Inc., San Bruno, Calif.*

For more information circle **318** on inquiry card.

OSCILLOGRAM READER

New Oscillogram Reader is said to reduce linear or non-linear, opaque or translucent oscillograms to data,

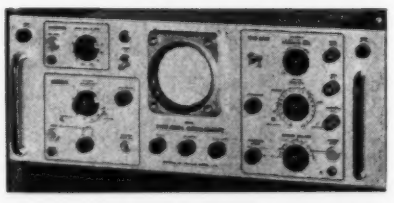


prepared for plotting, typing, tape perforating or card punching.—*Telecomputing Corp.*, 16217 *Lindbergh St., Van Nuys, Calif.*

For more information circle **319** on inquiry card.

OSCILLOSCOPE

New Type RM16 is a dc-to-mc 3" rack-mounting oscilloscope measuring only 7" high, 19" wide, 16¾" rack depth. A single knob is used to select any of 22 calibrated sweep rates from

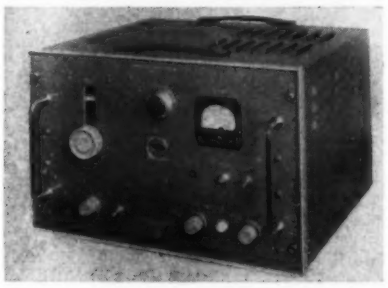


0.2 usec/div to 2 sec/div. Four-way triggering provides amplitude-level selection with either preset or manual stability control, fully automatic triggering, and high-frequency sync. Booths 1701 and 1702.—*Tektronix, Inc., PO Box* 831, *Portland* 7, *Ore.*

For more information circle **320** on inquiry card.

STABILIZED OSCILLATOR

New Model 815 X-band Ultra-stable oscillator covers 9000 to 10500 megacycles. Delivering from a 40/U choke

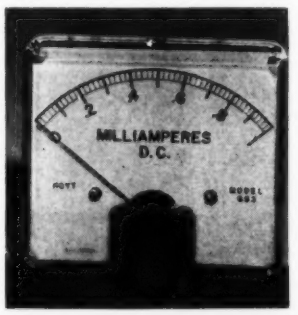


flange, maker claims short-term stability of five parts in 10^8 and long term stability of one part in 10^6 obtained by means of an invar reference cavity and a high gain, low-noise feedback amplifier. See in booths 2808-9. —*Laboratory for Electronics, Inc.*, 75 *Pitts St., Boston* 14, *Mass.*

For more information circle **321** on inquiry card.

PANEL METERS

New Hoyt high-visibility Panel Meters in anti-static, clear polystyrene cases now feature custom matched colors on the lower frosted

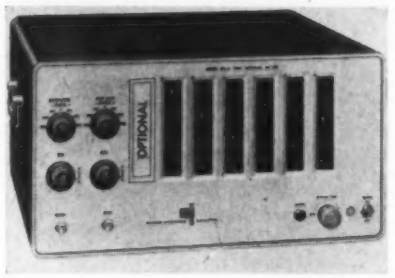


panel for functional identification. Available in all standard ac and dc scales, see in booth 2219.—*Burton-Rogers Company*, 42 *Carleton St., Cambridge* 42, *Mass.*

For more information circle **322** on inquiry card.

INTERVALOMETER

New CMC Model 251-A time interval meter is designed for precise measurement of elapsed time between two events occurring in the range of 3 microsec to 1 sec. Optional features permit extension to 10 or 100,000 seconds. Booths 904-905.—*Computer-*



Measurements Corp., 5528 *Vineland Ave., North Hollywood, Calif.*

For more information circle **323** on inquiry card.

FREQUENCY METER

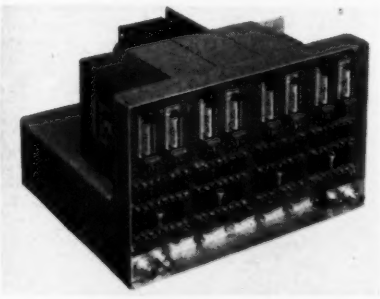
New Model 503 transistorized Meter provides direct frequency measurements from 3 to 100,000 cps in nine separate ranges. Accuracy is claimed

completely independent of input voltage waveform and amplitude in both battery and ac operation, a transistorized regulator preventing voltage variations from affecting measurement accuracy. Where tachometry is the primary requirement, the Model 503A Tachometer provides direct calibration from 60 to 6,000,000 rpm. Booth 1310.—*Cubic Corp.*, 5575 *Kearny Villa Road, San Diego* 11, *Calif.*

For more information circle **324** on inquiry card.

DELAY LINE

New Signal Enhanced Delay Line, to be seen in booths #609-610, consists of several sections, each composed of a delay line, an amplifier, a video transformer, a clipping diode and a cathode follower. Improvement in pulse fidelity resulting indicates applications in demodulators for pulse

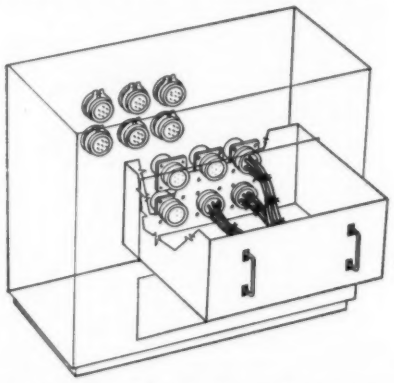


code trains as in Air Traffic Control systems and in computer operation where narrow pulses permit increase in rapidity of calculation.—*Packard-Bell Electronics Corp., Technical Products Div., 12333 W. Olympic Blvd., Los Angeles 64, Calif.*

For more information circle **325** on inquiry card.

MULTIPLE CONNECTORS

New single-drawer application of Deutsch rack and panel connectors in multiple mountings on cam-locked, push-in drawers will be shown in

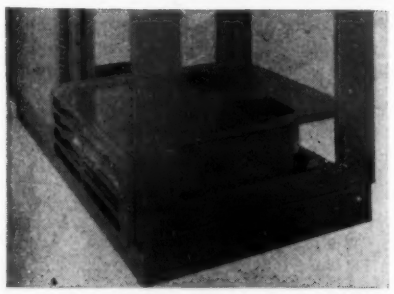


booth 2510. All of the units connect, lock, and seal environmentally when the drawer is pushed in. All connections are broken simultaneously when the drawer is opened.—*The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.*

For more information circle **326** on inquiry card.

BLOWER

New Model B350 blower recesses in base of Amco Modular frames to pro-



vide 350 cuft/min filtered air. Will be shown in booths 3217 and 3218.—*Amco Engineering Co., 7333 W. Ainslie St., Chicago 31, Ill.*

For more information circle **327** on inquiry card.

RESISTORS

New line of Type ME Metal Film Resistors in ratings of ⅛, ¼, ½, 1, and 2 watts, are said to combine high accuracy and stability with low and controllable temperature coefficients. Also low capacitance and inductance values permit their use in high frequency applications. Also, other new developments in booths 521-2.—*International Resistance Co., 401 North Broad St., Philadelphia 8, Pa.*

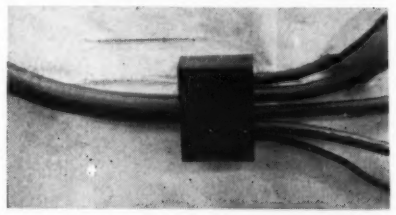
For more information circle **328** on inquiry card.

BLOWER DESIGN

A new device assists electronic designers in getting the most efficient cooling possible for planned equipment installations which incorporates interchangeable blower parts and set-ups. Booths 916-17.—*Air-Marine Motors, Inc., Amityville, N. Y.*

For more information circle **329** on inquiry card.

CABLE BREAKOUT

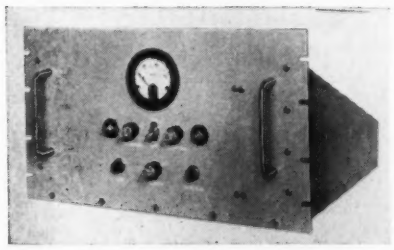


New strain relief breakout for multiconductor neoprene jacketed cable assemblies features potted construction, strength, light weight, and minimum space. Booth 2412.—*Pacific Automation Products, Inc., 1000 Air Way, Glendale, Calif.*

For more information circle **330** on inquiry card.

VOLTAGE REGULATOR

New Stabiline Automatic Voltage Regulator type EM10009, designed for 400 cycle applications, is suited for low temperature operations and applications which demand a constant output voltage with zero waveform

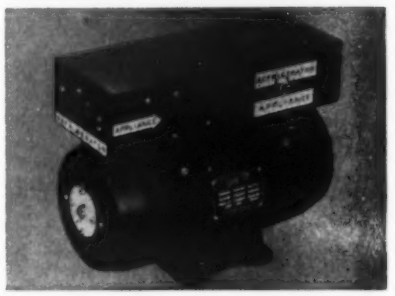


distortion. Originally produced for radar control, it meets specification MIL-E-4158. On display at booth numbers 2109 and 2110 with other Stabiline Models and 400-cycle Powerstats.—*The Superior Electric Co., 83 Laurel St., Bristol, Conn.*

For more information circle **331** on inquiry card.

DC-AC CONVERTERS

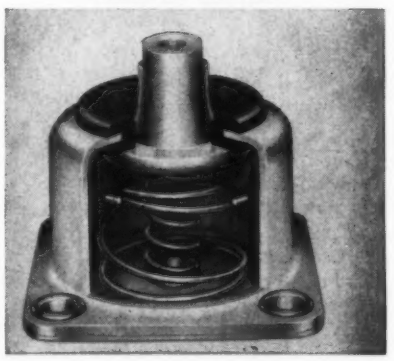
New 750-watt refrigerator-appliance automatic marine converter (illustrated) runs appliances aboard small boats from DC or battery power. Weight 65 pounds. Output 750 watts.



Seven models operate automatically on from 24 to 230 v dc input to provide power when called for by appliance. Also 20, 40, or 60 watt dc to ac Geneverters and 40 to 150 watt Mark II Super Converters. At booth No. 2616.—*Carter Motor Co., 2704 W. George St., Chicago, Ill.*

For more information circle **332** on inquiry card.

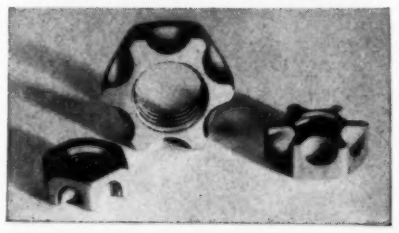
SHOCK MOUNT



New L44 vibration isolator is available in 7 load ranges from 0.25 to 10 pounds per mount. Features full compliance with MIL-C-172B plus friction damping and independent horizontal damping. Booths 1805-6. —*Barry Controls Inc., 880 Pleasant St., Watertown 72, Mass.*

For more information circle **333** on inquiry card.

LIGHTWEIGHT LOCKNUTS



New lightweight steel locknuts now available in the 10-32 and ¼-28 sizes, are said to save up to 49% weight with holding strength of conventional locknuts. Booths 3213-14 —*Standard Pressed Steel Co., Jenkintown, Pa.*

For more information circle **334** on inquiry card.

TEST CHAMBER

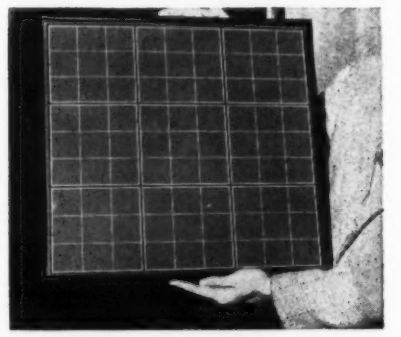
New ten cubic foot environmental test chamber designated the Tenney Ten model. Temperature limits avail-

able are from −120°F to +350°F. Relative Humidity to meet military cycling specifications is optional. Booth 918.—*Tenney Eng., Inc., 1090 Springfield Rd., Union, N. J.*

For more information circle **335** on inquiry card.

SUN BATTERY

New selenium Sun Battery, consisting of nine 6" x 6" B-60 selenium cells developed to convert solar energy to electrical current for a wide

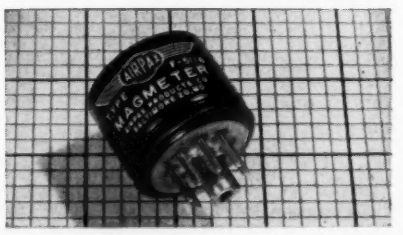


variety of applications where size is not a critical factor. Per milliwatt of output, the initial cost of this selenium sun battery is said to be fifty percent less than those of other semiconductor materials. Booths 1501-2.—*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*

For more information circle **336** on inquiry card.

FREQUENCY DETECTOR

New Magmeter type F-5116 frequency detector has range to 10 KC,

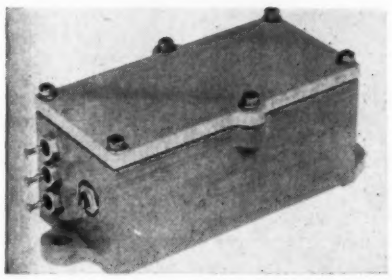


said to be twice the frequency range heretofore available. These detectors are used in instantaneous pulse rate indicators, electronic tachometers, direct-reading frequency meters, and automatic speed controls. Operates directly from 115-v line or from a vacuum tube driver. Booths 416-17.—*Airpax Products Co., Fort Lauderdale, Fla.*

For more information circle **337** on inquiry card.

ACCELEROMETER

New type 940 accelerometer first used in a toss bombing control system is said to cover a wide range of static or uniformly varying type of accelerations. Potentiometer or inductive

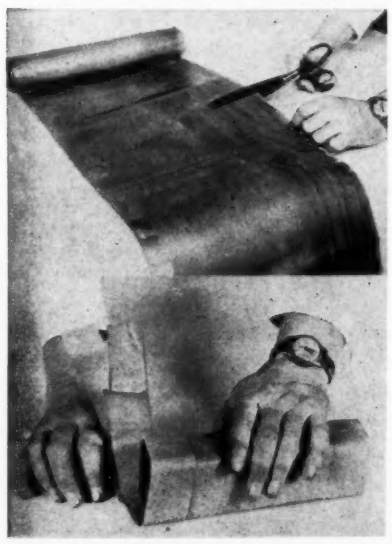


type pick-offs, and variations of conformation, G-ranges, natural frequency and damping will be developed to meet special customer requirements. Booths 3021-2.—*Fairchild Camera & Instrument Corp., Robbins Lane, Syosset, Long Island, N. Y.*

For more information circle **338** on inquiry card.

MAGNETIC FOIL

New Netic and Co-Netic magnetic shielding now available on lightweight flexible foils for low and high fre-

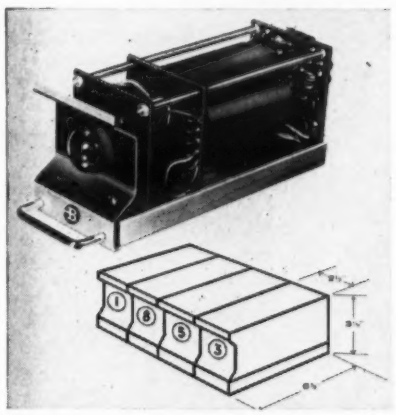


quencies at low intensities. Uses are claimed in component fabrication, packaging, laboratory shielding (used as wallpaper); can be painted or cemented; retains shape when formed and folded. See in booth 3018.—*Magnetic Shield Div., Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill.*

For more information circle **339** on inquiry card.

DECADE COUNTER WITH NIXIE READOUT

New Decade Counter made up of Beam Switching Tube Type 6700 and Nixie Indicator Tube Type 6844, the unit displays numerical information that is directly controlled by a single counter tube. Plug-in units have a

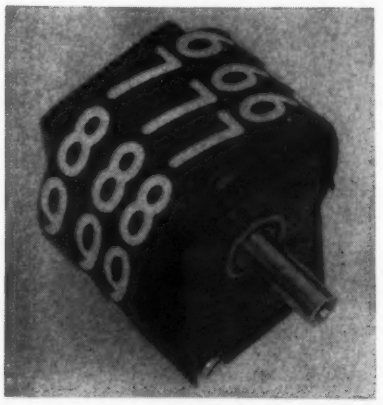


minimum panel height ($3\frac{3}{16}$"), are visible 30 to 40 ft, and may be cascaded to provide any desired count capacity with provisions for manual and electronic zero setting. Booths 3121-23.—*Electronic Tube Div., Burroughs Corp., Plainfield, N. J.*

For more information circle **340** on inquiry card.

COUNTERS

New compact internal-pinion-type counters available in two, three, four, five and more digit versions are capa-



ble of operating at speed above 500 rpm. Models 500097 and 500098 will be shown at booth 709.—*Bowmar Instrument Corp., 2415 Pennsylvania St., Fort Wayne, Ind.*

For more information circle **341** on inquiry card.

PRINTED CIRCUIT LAMINATES

New copper-clad laminates for printed circuits including: *FF*-89—a new flexible glass epoxy laminate; *Cirprint*—for volume manufacturers exceeds NEMA standards for XXP, has insulation resistance of 250,000 megohms. It is available in sheet sizes to 36" x 96" with thicknesses ranging from 1/32" to ¼"; *FF*-91-1—for high flexural strength at elevated temperatures; heat resistance

to solvents and strong alkali solutions. See in booths 3302-3.—*Formica Corp., 4614 Spring Grove Ave., Cincinnati 25, Ohio.*

For more information circle **342** on inquiry card.

MAGNETIC COUNTER

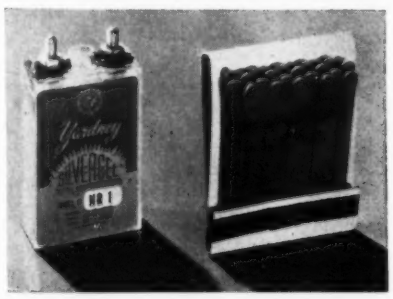
New Model MCRP-700 is a compact, high-speed, precision counter to add or subtract electrical pulses with electrical reset to any predetermined number. Can be furnished as a three,

four, or five digit counter with any combination of add, subtract, and microswitch control at zero level. See in booth 3212,—*Photocon Research Products, 421 North Altadena Drive, Pasadena, Calif.*

For more information circle **343** on inquiry card.

MISSILE BATTERIES

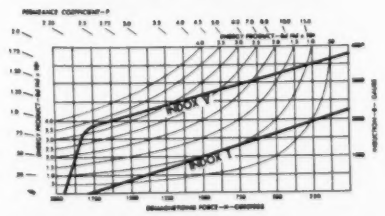
New line of silver-zinc cells ranging from stamp-sized HR01, to 300-ampere-hour LR300, are said to provide up to five times more power



than other similar-sized batteries. Can serve as basic sources of high-voltage energy in missiles for servo controls and guidance systems. Booth 2615.—*Yardney Electric Corp. 40-50 Leonard St., New York, N. Y.*

For more information circle **344** on inquiry card.

CERAMIC MAGNETS

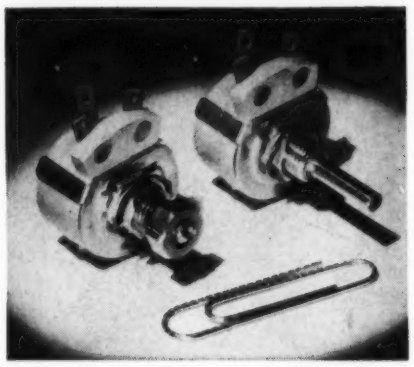


New Indox V barium-ferrite ceramic permanent magnets, said to be 3½ times stronger than present ceramic magnets, and to require less space, weight to do the same job, contain no critical materials.—*The Indiana Steel Products Co., Valparaiso, Ind.*

For more information circle **345** on inquiry card.

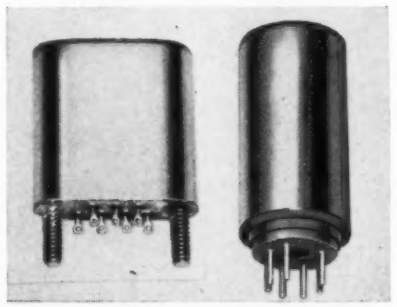
POTENTIOMETERS

New Series 49M miniaturized wirewound potentiometers, are said to have higher dielectric strength; exceptionally low are ¾" X ½" 1.5; 4 to 20,000 ohms. Booth 1326.—*Clarostat Mfg. Co., Inc., Dover, N. H.*



For more information circle **346** on inquiry card.

COMPUTER UNITS

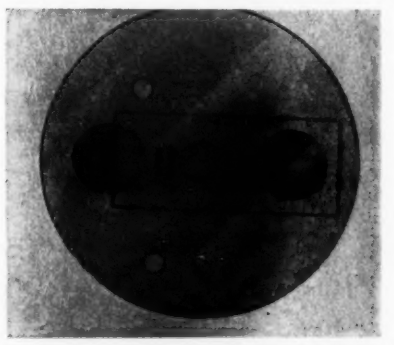


New transistorized "P series" plug-in and "C series" cartridge assemblies for computer circuits, including binary counters, triggers, delay multivibrators, and dual emitter follower amplifiers, in epoxy encapsulated units will be shown in booth 501.—*The Walkirt Co., 141 West Hazel St., Inglewood 3, Calif.*

For more information circle **347** on inquiry card.

BOLOMETERS, THERMISTORS

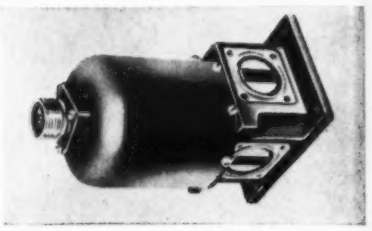
New broadband disc bolometers for coaxial detectors, Models N603 and N603-4.5, and a new broadband disc thermistor, Model N335, all covering the frequency range from 500 to 10,000 mc, will be shown in booths 817 and 818, with other microwave specialties.—*The Narda Corp., Mineola, L. I., N. Y.*



For more information circle **348** on inquiry card.

WAVEGUIDE SWITCH

New miniature waveguide 3-position switch will not change position if power fails. Available in X_S and

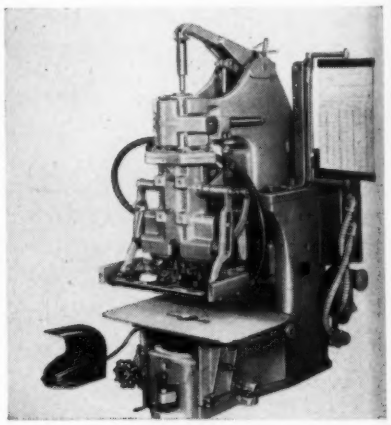


X_L band series, r-f and pressurized fittings are built into switch, giving up to 20 pounds of pressurization throughout. At booth No. 2822.—*Airtron, Inc., Dept. C., Linden, N. J.*

For more information circle **349** on inquiry card.

ASSEMBLY MACHINES

New machines are capable of inserting different types of components into printed wiring boards. Several models of Dynasert semi-automatic

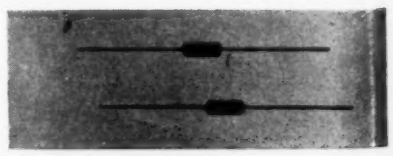


machines, including the illustrated No. 3 Component Inserting Machine, will be demonstrated in booths 1219-20.—*United Shoe Machinery Corp., 140 Federal St., Boston, Mass.*

For more information circle **350** on inquiry card.

SILICON DIODES

New silicon diodes have operating voltages extending to 200 v, and operate in temperatures to 150°C. Can often directly replace germanium or

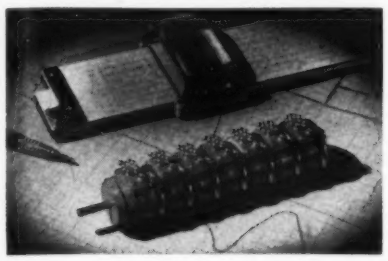


vacuum types in military computers where temperatures are critical. See in booth #2801-02.—*Transitron Electronic Corp., Melrose* 76, *Mass.*

For more information circle **351** on inquiry card.

NONLINEAR POTENTIOMETERS

New nonlinear precision wire-wound potentiometers for sine-cosine and



square-law functions are said to assure high resolution and close conformity for generation of functions, transmission of angular information, nulling in nonlinear systems, and electro-mechanical data conversions. Meet military specifications. Booth 2720—*Ace Electronics Associates, Inc., Somerville, Mass.*

For more information circle **352** on inquiry card.

WAFER DRY CELL

New cell, said a third more powerful than conventional flat cells, is made by machine. 15 wafers stacked and

wrapped with plastic are sealed in aluminum tube to make 22½ volt battery for transistorized test equipment, radios, Geiger counters, etc. Booth 1327.—*Burgess Battery Co., Freeport, Ill.*

For more information circle **353** on inquiry card.

ELECTRONIC KILOVOLTMETER

New kilovoltmeter is designed to measure voltages of waveforms, including pulses at frequencies of 10 cps to 20 megacycles with accuracy of ±3 per cent; linear meter scale provides full-scale readings of 2.5, 5, 10, 25, 50, and 100 kilovolts. A jack is provided on front panel to permit use of an oscilloscope for visual observation of waveforms. Booths 1516-17—*Jennings Radio Mfg. Corp., Box* 1278, *San Jose, Calif.*

For more information circle **354** on inquiry card.

TRANSPARENT PHOSPHORS

New phosphor applied in an extremely thin "molecular" transparent layer, permits spot and line resolution to approach the diameter of the electron beam.—*General Electric Co., Schenectady* 5, *N. Y.*

For more information circle **355** on inquiry card.

TRANSISTORIZED AMPLIFIER

New transistorized carrier amplifier will deliver an output of approximately 9/10 watt into a 70 ohm load, with distortion of 2%. Input can vary from 0 to 100 millivolts; input impedance is approximately 20,000 ohms. Required power supply voltage is 28 v ±2 v at approx. 500 ma and 150 vdc at 30 ms. Booth 3010.—*Rheem Electronics Div.,* 7777 *Industry Ave., Riviera, Calif.*

For more information circle **356** on inquiry card.

CRYSTALS

New hi-temperature, hi-stability 5 mc crystal, also Sapphire Mount delay lines with intervals from 3 to 4500 microseconds, and new type crystal ovens. Booth 1725.—*Bliley Electric Co.,* 200 *Union Station Bldg., Erie, Pa.*

For more information circle **357** on inquiry card.

FUNCTION PROGRAMMER

New function programmer provides switching as well as potentiometer control of electrical and electronic circuitry in relation to time. Reduction-gear speed-regulated d-c motor moves contacts at constant speed. Tests subjected programmer to vibration up to 20G between 20 and 2000 cps in three planes, acceleration up to 50G in six directions, and 100G of shock for 1.3 milliseconds in six directions. Booth 2130.—*Hubbard Scientific Labs. Inc.,* 1292 *East Third St., Pomona, Calif.*

For more information circle **358** on inquiry card.

R-F SIGNAL GENERATOR

New Model 82 Signal generator is designed for general laboratory and field work where high accuracy is required. Power chassis and five plug-in oscillator assemblies cover most-used portions of spectrum from 20 to 3000 mc; CW and pulsed output, 2.3 microvolt to 22.5 v, variable from −80 to +43 dbm; stability, ±0.1%; accuracy ±0.5%. Also other r-f test instruments.—*BJ Electronics, Borg-Warner Corp.,* 3300 *Newport Blvd., Santa Ana, Calif.*

For more information circle **359** on inquiry card.

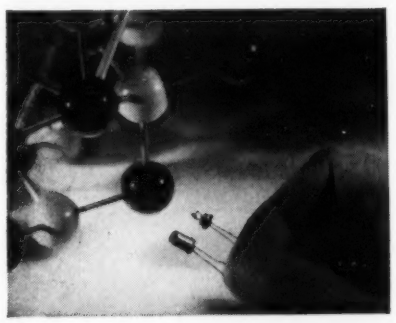
ANGLE CONVERTER

New, lightweight, IDL shaft angle converter converts rotary motion into coded system of numbers for use in airborne, military and industrial applications. It provides a binary decimal read-out of 1 in 3600 counts at 40 codes per revolution of the input shaft. Max. speed 300 rpm. Booth 2907.—*Instrument Development Laboratories, Inc.,* 67 *Mechanic St., Attleboro, Mass.*

For more information circle **360** on inquiry card.

BISTABLE DIODE

New Shockley Low-power four-layer switching diode, a two-terminal silicon device, has two states: when driven to its closed (1 to 10 ohm) state by application of a voltage greater than the critical breakdown



point, it will continue conductive so long as a current greater than a critical holding current (about 25 ma) is maintained. When the current is reduced below the holding value, the device regains its open (1-100 megohm) state. Booth 1406.—*Shockley Semiconductor Lab., Beckman Instruments, Inc.,* 137 *San Antonio Rd., Mountain View, Calif.*

For more information circle **361** on inquiry card.

COMPONENT CLIPS

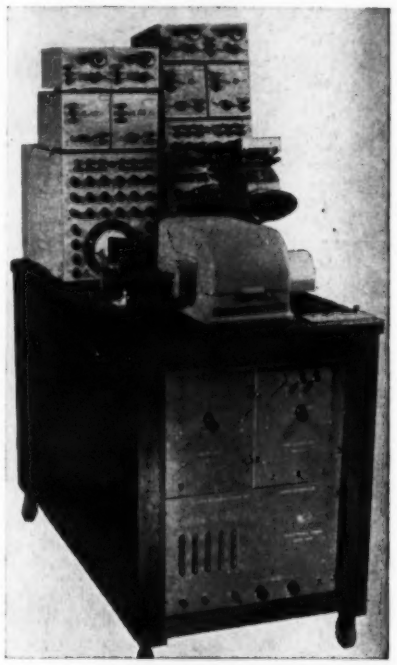
New line of clips for mounting on printed circuit boards, with excellent holding features under vibration and shock, are capable of taking five 90 deg. bends without fracture. Of beryllium copper, finished by electro-tinning over copper flash, clips maintain tight grip on components over wide vibration range. Booth 404.—*Atlas E-E Corp.,* 47 *Prospect St., Woburn, Mass.*

For more information circle **362** on inquiry card.

MA New Products

Also see NEW AT WESCON products beginning on page 224

CATHODE-RAY RECORDING SYSTEM



New Model 204 Dynamic 4-channel recorder designed for thrust, pressure, and temperature measurements in the field includes bridge elements, amplifiers, cathode-ray oscillographs, automatic calibrators, crystal-controlled time standard, drum camera, and camera-and calibrator-control and synchronizing circuits.

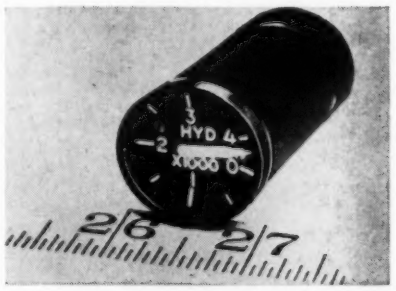
The basic circuitry of the amplifiers consists of a 50 kc electronic inverter and ac amplification stages which permit the use of stable dc-excited transducer bridges while using stable ac amplifiers to accurately record signal frequencies down to dc. Two or more 204's can be synchronized to record additional channels.

Performance specifications: Sensitivity—0.001 volts/inch peak to peak; Drift (referred to input)—100 microvolt/hour; Noise (referred to input)—20 microvolt/hour rms; Frequency Response—0-5000 cps (Model 204 D) or 0-20,000 cps (204A).—*Allegany Instrument Company, Inc.*, 1091 *Wills Mountain, Cumberland, Md.*

For more information circle **363** on inquiry card.

SYNCHRO INDICATOR

New aircraft synchro indicator (Type 26800), meeting military specification I-25540A, designed for 26 vac 400 c. operation, weighs less than



3 oz. Dials are available for aircraft installation to indicate compass heading, flap, wheel or other component operating positions. Both dials and pointers are available in various finishes, such as matte white, fluorescent, or radium.—*Bendix Aviation Corp., Montrose Div., Montrose, N. Y.*

For more information circle **364** on inquiry card.

INSTRUMENT TRANSLATOR

New transistorized instrument translator is said to permit substitution of variable reluctance pickoffs for potentiometers in aircraft and missile systems without adding con-

siderable size and weight. Translator receives power from the system power source and when connected with a suitable ac sensing transducer it produces a dc or ac signal which is proportional to the physical changes sensed by the transducer.—*Crescent Engineering & Research Co.*, 5440 *North Peck Road, El Monte, Calif.*

For more information circle **365** on inquiry card.

PARABOLOID ANTENNA

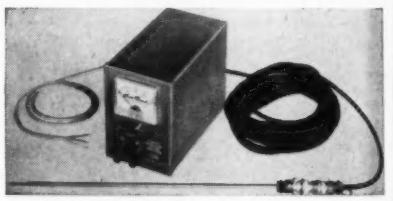
New model GB 60, 90 and 120 Precision Parabola antenna for scatter propagation are suitable for adap-

tation to pedestal mechanisms to allow accurate orientation for radar and interstellar space studies. Complete with control mechanisms, the parabolas are said to feature minimum weight, maximum reliability and fastest erection in the field.—*General Bronze Corp.*, 711 *Stewart Ave., Garden City, N. Y.*

For more information circle **366** on inquiry card.

ANEMOMETER

New constant temperature hot wire anemometer for military testing applications requires no batteries, no time-constant testing or gain settings.



Output impedances are 10K and 100 K ohms. Claimed frequency response is from dc to 1000 cps, with other systems to 60,000 cps also available, and noise level under 1% of mean flow level.—*Aero Research Instrument Co.*, 315 *N. Aberdeen St., Chicago 7, Ill.*

For more information circle **367** on inquiry card.

UHF CONVERTER

New model UHC-R uhf Converter, said to have a noise figure of from 5.5 to 8.5 db in the 400-900 mcs region, and a minimum overall gain of 50 db, for a 5 mc bandwidth. Out-

put frequency is factory preset at 30 or 60 mcs. Consists of a radio frequency amplifier and a converter unit.—*Applied Research Inc.*, 163-07 *Depot Road, Flushing, L. I., N. Y.*

For more information circle **368** on inquiry card.

AIRCRAFT TEMPERATURE SYSTEM CHECKER

New TEMPCAL Tester checks thermal switch and continuous wire systems for accuracy either on the

aircraft or "on the bench" in production; also checks cylinder head thermocouple systems. It performs a functional test of the overheat detector system by supplying through the Tempcal Probe a controlled "artificial" heat to simulate operating temperatures. Accuracy is guaranteed to ±5°F. with temperatures ranging from 0°F. to 800°F.—B&H Instrument Co., Inc., Fort Worth 7, Texas.

For more information circle **369** on inquiry card.

MISSING PULSE DETECTOR

New Model PD11A, for checking the performance of pulse-modulated tubes incorporates two inputs, one for the negative detected rf pulse, the other for a negative reference trigger. The rf pulse forms a negative

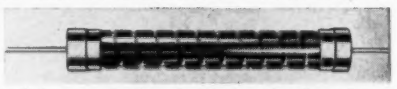
gate for squelching the reference trigger. In the case of a missing pulse, the output is a positive 15-volt pulse registered on a counter (not a part of the set.)

The set is capable of checking pulses of 0.2 to 6.0 micro-seconds in width, at rep rates up to 5000 pps.—*Manson Laboratories, Dept. M,* 207 *Greenwich Ave., Stamford, Conn.*

For more information circle **370** on inquiry card.

METAL FILM RESISTORS

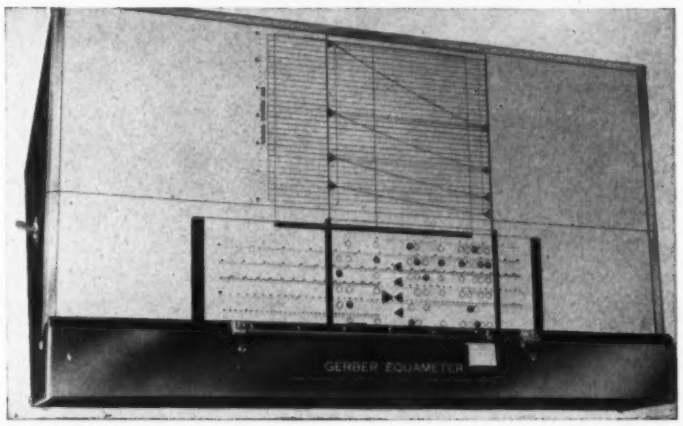
New series 850 hermetically sealed metal film resistors are said to offer the lowest noise level available, low



resistance values (2 to 4 ohms), no plastic dielectric loss, no semiconductor effect, temperature range from −65°C. to 150°C; same positive temperature coefficient for all resistors from 2 ohms to 4 megohms.—*The Daven Co.,* 530 *W. Mt. Pleasant St., Livingston, N. J.*

For more information circle **371** on inquiry card.

EQUAMETER

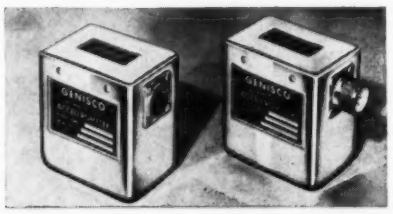


New Model GEQ-450 "Equameter" is manually operated computing device which performs harmonic analyses and curve-fittings on plotted or recorded curves. Derivative or integral equations of a given curve can be obtained directly from readings taken from the EQUAMETER and recorded on specially designed data sheets by an engineering aide with little or no mathematical background, which makes it a practical instrument for small laboratories. Larger installations will find it extremely useful for converting raw data to a form acceptable to large digital or analog computers, and in fitting polynomial equations to curves or test points. A 12-term Fourier analysis can be obtained in about 7 minutes.—*The Gerber Scientific Instrument Co.,* 162 *State St., Hartford* 3, *Conn.*

For more information circle **372** on inquiry card.

AC ACCELEROMETER

New Model GAL accelerometer for aircraft fire control is said to provide: high sensitivity high linear a-c



output with low sensitivity to all but linear accelerations; operation unaffected by rough vibration; high linear and stable damping over the ambient range without heaters; and solder-sealed hermetic encapsulation.—*Genisco, Inc.,* 2233 *Federal Ave., Los Angeles* 64, *Calif.*

For more information circle **373** on inquiry card.

PRECISION POTENIOMETER

New rack mounted potentiometer shown has a double range, 0 to 1.11 volts and 0 to .111 volts. Each range is divided into 10 equal steps on a decade switch, and a slidewire equal to 1.1 step with 200 divisions, giving 5 millivolt/div. on the high range and .05 mv/div. on the low range. The galvanometer has a sensitivity of 80 micro-volts per div. Battery and standard cell are chassis mounted.—*Gray Instrument Co.,* 200 *E. Church Lane, Philadelphia* 44, *Pa.*

For more information circle **374** on inquiry card.

RATE GYROSCOPE

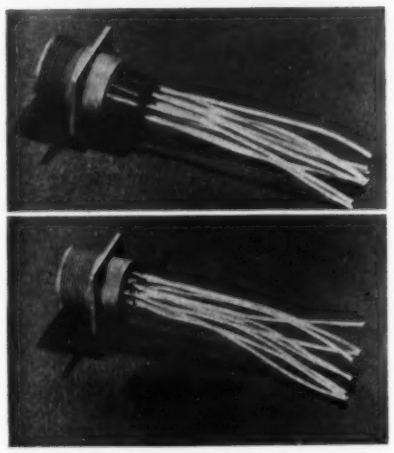
New Golden Gnat high performance miniature rate gyroscope designed for small size, light weight and ability to withstand the most severe environment has applications in autopilot damping, radar antenna stabilization and fire control.

Features: 1" by 2¼" 3.8 oz. Wide Range of Full Scale rates up to 600°/sec. Threshold and Resolution 0.01°/sec (ratio of gimbal inertia to angular momentum); 0.00045 sec. Excellent Linearity, 0.1% of full scale to ½ range, within 2% to full range; Ambient Temperature Range (operating) −55°C to +85°C.—*Minneapolis-Honeywell, Boston Div.,* 1400 *Soldiers Field Rd., Boston* 35, *Mass.*

For more information circle **375** on inquiry card.

New Products—*Cont.*

EPOXY STRIPPER

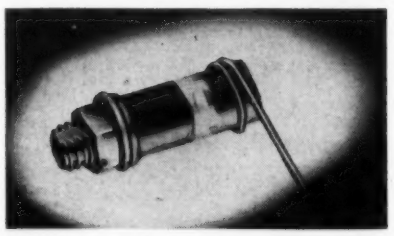


New non-inflammable Monastrip EP is said to reduce and remove Minnesota Mining's Scotchcasts, Shell's Epons, Ciba's Araldite, Westinghouse's Fosterite, Bakelite's Epoxy Resins and many others, to permit salvage or repair of potted assemblies. It does not injure copper, aluminum, ferrous metals, or resin-based enamels. No special equipment is required; Monastrip EP can be reused after resin solids are strained off.—*Mona Industries, Inc., Paterson* 4, *N. J.*

For more information circle **376** on inquiry card.

TRIMMER CAPACITOR

New miniature trimmer model VC20G piston capacitor ranging in capacitance from .8 to 8.5 mmf, features $\frac{9}{16}$" length. Superior tuning

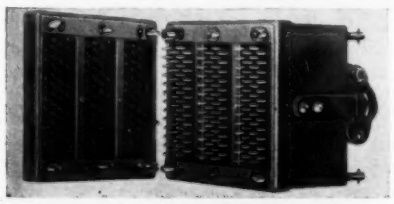


resolution and freedom from corrosion and tuning noise are claimed by maker.—*JFD Manufacturing Co., Inc.*, 6101-16*th Ave., Brooklyn* 4, *N. Y.*

For more information circle **377** on inquiry card.

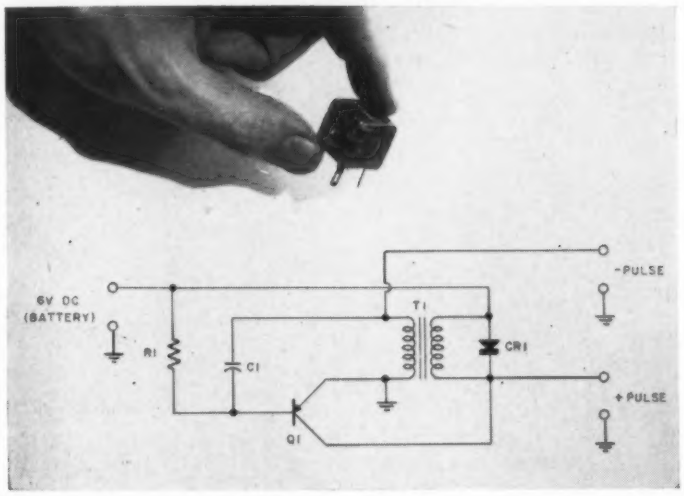
SCREW-LOCKING CONNECTORS

New multiple modular design permits expansion of Series MI-BSL miniature screw-locking connectors up to 250 contacts. "Floating Body Isolation" insures vibra-shock protection and high environmental resistance through complete separation of electrical and mechanical elements. Available in glass-reinforced Alkyd, mineral-filled Melamine, or diallyl Phthalate, 100,000 megohm insulations to meet MIL specs, contacts have a 5-amp current and 2600 volts ac (rms) voltage-breakdown rating. —*U.S. Components, Inc.*, 454 *East* 148*th St., New York* 55, *N. Y.*



For more information circle **379** on inquiry card.

PULSE-UNIT CUBE



New trigger pulse source including subminiature pulse transformer, transistor, capacitor, resistor, and crystal diode is packaged in ¾-inch epoxy cube for use in guided missiles, airborne equipment, and miniaturized electronic laboratory instruments. Pulse-cube produces a pulse of 3 usec. duration with a rise time of 0.06 usec. Fixed repetition rates of 25 kc, 1 kc, or a variable repetition rate from 400 cps to 24 kc are available. Approximately 1,000 hours of operation on a miniature six volt mercury cell is achieved. Pulse-Cubes can be redesigned to meet specifications for special uses.—*Allen B. Du Mont Laboratories, Inc.*, 760 *Bloomfield Ave., Clifton, New Jersey.*

For more information circle **378** on inquiry card.

CABINET RACK

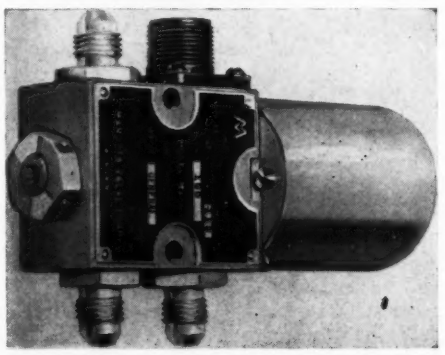
New POR series desk cabinet rack finished in two-tone gray and brown

hammertone is available in 20 sizes with ten different panel heights to fit standard 19" widths and in both 15¼" and 18" depths.—*Premier Metal Products Co.*, 337 *Manida St., New York* 59, *N. Y.*

For more information circle **380** on inquiry card.

SOLENOID VALVE

New line of solenoid high pressure gas valves for 115 volt, 400 cycle A.C. service, is exemplified by Model MV74B balanced-poppet valve. This

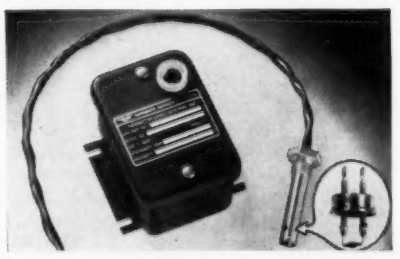


3-way, 2-position unit is rated for 3000 psi service, can be used either normally open or normally closed, and weighs less than 1.0 lbs. Other types are also available.—*Marotta Valve Corp., P. O. Box* 330-48, *Boonton, N. J.*

For more information circle **381** on inquiry card.

LEVEL SENSING SYSTEM

New Liquid Level Sensing System operates a light to indicate whether

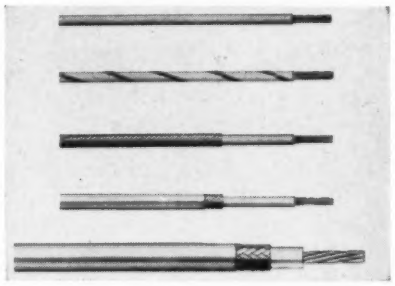


a hydrocarbon liquid is above or below a certain level, actuates a control to start and stop pumps, or operates valves to transfer liquids from one tank to another. Systems also can be designed for many liquified gases including the following: Liquid oxygen, liquid nitrogen, liquid hydrogen, liquid anhydrous ammonia.—*Simmonds Aerocessories, Inc.*, 105 *White Plains Rd., Tarrytown, N.Y.*

For more information circle **382** on inquiry card.

TEFLON CABLES

New series T line of Teflon-insulated wires and cables encompasses hook-up wires, miniature coaxial and RG/U coaxial cables and multiconductor cables with extruded and spir-



ally wound and fused Teflon insulations from AWG 32 through AWG 10. —*Times Wire & Cable Co., Wallingford, Conn.*

For more information circle **383** on inquiry card.

HI-PRESSURE BLOWER

New Model L multistage centrifugal blowers allow delivery of 25 to 350 cfm at static pressure of 10 to 55 inches water column (2 psi) on suction or pressure. Model L con-

struction provides small size, light weight and low noise as required by electronic instrument and computer applications. Integral airfilters and outlet manifolds available.—*Rotron Manufacturing Co., Schoonmaker Lane, Woodstock, N. Y.*

For more information circle **384** on inquiry card.

HASTINGS ALTIMETER

New Model SP-1A, altimeter said to be accurate in the high altitude ranges of from 75,000′ to 225,000′ measures altitude by means of a low pressure transducer which generates a d.c. voltage, increasing with altitude. Maximum sensitivity in the range of a few millimeters of mercury, (where mechanical altimeters are insensitive), minimum response lag, and compatible with recording, control or telemetering systems are features claimed for the instruments. The new altimeter is offered for applications in altitude chambers, wind tunnels, enviromental testing, and aircraft, rocket and missile research.—*Hastings-Raydist Inc., Hampton, Va.*

For more information circle **385** on inquiry card.

UHF BEAM POWER TUBES

New types 6816 and 6884 are very small forced-air-cooled beam power tubes designed for use as uhf power amplifiers, oscillators, and frequency multipliers as well as af power amplifiers and modulators. Differing only in heater characteristics operating with a rating of 115 watts in modulator and CW service to 1200 mc, or with reduced ratings to 2000 mc, these types are especially suitable for use in cathode-drive circuits. The heater in the 6816 operates at 6.3 v./2.1 amperes, and that in the 6884 at 26.5 v./0.52.—*Radio Corporation of America, Tube Div., Harrison, N. J.*

For more information circle **386** on inquiry card.

HI-VACUUM FUSE

New Fuse which glows when operating at normal load operates in the highest obtainable vacuum to prevent when the fusible elements blow. Rating: Normal Load current 50 ma, Open Cir. current 100 ma within 20 sec., breaking 1300 volts either at 50,000 ft. alt. or at sea level. Said to conform to all environmental test conditions including vibration and metal corrosion, OK positive protection fuses can also be supplied to customer's specifications.—*OK Electronics Corp., 7 Hunt Place, Nutley, N. J.*

For more information circle **387** on inquiry card.

HV FILAMENT TRANSFORMERS

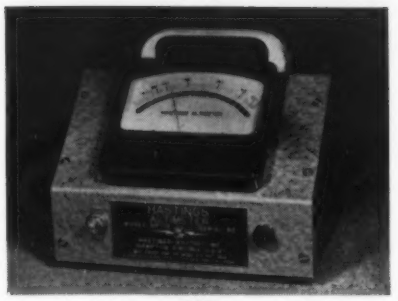
New low capacity filament transformer is insulated for 50 kv and is rated at 115v/10v, 10a. Capacitance between secondary and frame is 20 $\mu\mu$fd. Other designs to suit special requirements.—*Del Electronics Corp.* 39-41 *North MacQuesten Parkway Mount Vernon, N. Y.*

For more information circle **388** on inquiry card.

PLUG-IN RELAY

New 2, 4, and 6-pole plug-in relays that cannot be plugged into a socket incorrectly help solve manufacturer's assembly problems with mounting hardware that enables the same relay to be used for above or below chassis mounting. Different heights of mounting flanges and indexing pins prevent interchange of latching and general purpose relays in the same receptacle.—*Filtors, Inc., Port Washington, N. Y.*

For more information circle **389** on inquiry card.



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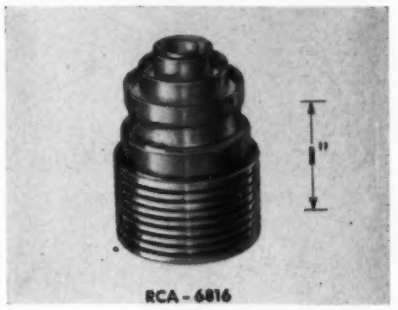

RCA-6816
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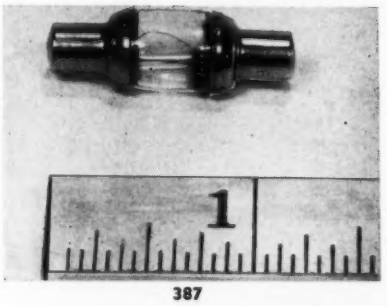

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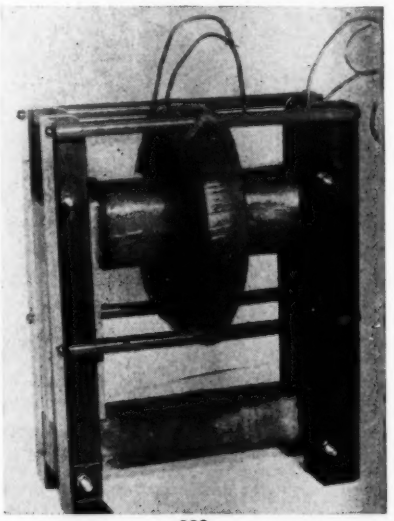

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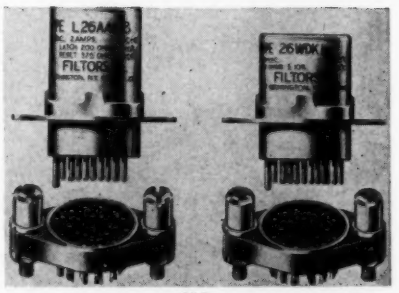


389

New Products-*Cont.*

WIDEBAND RECORDING

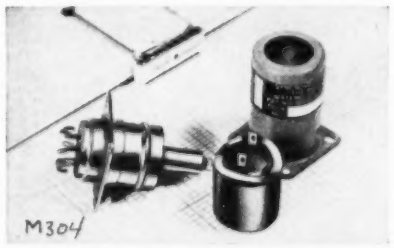
New "Minban" system with capacity of 112,000 data bits/inch on ½" wide magnetic tape is said to have applica-

tions in radar and TV video and in high-speed data recording. Frequencies from 200c to 2½ mc are directly recorded; FM techniques extend range to dc.—*Mincom Div., Minnesota Mining & Mfg. Co., Los Angeles, Calif.*

For more information circle **390** on inquiry card.

LOW-NOISE CHOPPER

New Syncroverter Switch, miniature, precision, non-resonant inverter, is now available in an exceptionally low-noise, external coil model for dry circuit applications. Chopper elimi-



nates capacitive coupling between contact and coil leads.—*The Bristol Co., Waterbury* 20, *Conn.*

For more information circle **391** on inquiry card.

CIRCUIT BREAKER

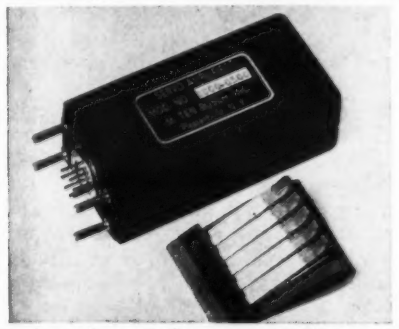
New AM17 circuit breaker reduces military airborne equipment stock requirements by functioning on either 400-cycle ac or dc without change in rating time-delay characteristics.

Although made in single-pole form only, Series AM17 breakers are readily linked in field without special tools to make two- or three-pole units. —*Heinemann Electric Company,* 105 *Plum St., Trenton* 2, *N. J.*

For more information circle **392** on inquiry card.

TRANSISTORIZED AMPLIFIER

New Model 1800-0500 "TRAMP" is a high temperature, miniaturized, hermetically-sealed, plug-in transistor servo amplifier primarily intended to



receive signals from a synchro control transformer and to operate a BuOrd MK 7 servo motor or equivalent. Input power 100v dc at 100 ma, 28 v dc at 12 ma.—*M. Ten Bosch, Inc., Pleasantville, N. Y.*

For more information circle **393** on inquiry card.

SCOPE DOLLY

New oscilloscope dolly includes storage area for scope preamp, three power outlets and extra 3-wire input receptacle. Scope is safely and easily wheeled to point of test, held at 20° reading angle.—*P. B. R. Mfg. Co., Philadelphia, Pa.*

For more information circle **394** on inquiry card.

TUBELESS POWER SUPPLY

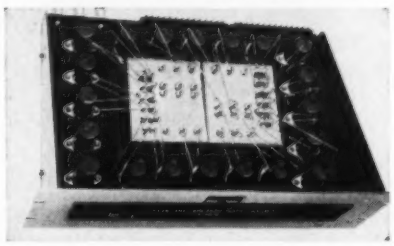
New Transiply all-transistorized regulated power supply is said to feature a stable, metered continuously-variable output, low impedance, no ripple, high current and availability of positive or negative bias.

Input voltage: 105-125 v, ac, 50-60 cps. Output: 0.5 v to 7.0 v, dc continuously variable, 0-300 ma—*Kay Electric Company,* 14 *Maple Ave., Pine Brook, N. J.*

For more information circle **395** on inquiry card.

VOLTAGE DIVIDER

New type RVD 105 Relay Operated Voltage Divider reference standard may be set up manually from a switch bank, or automatically from punched cards or tape. Applicable as

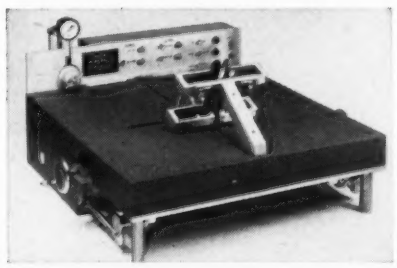


laboratory equipment, as a programmable standard in automatic measurement or readout applications, or as the heart of a digital voltmeter. Shielded chassis mounts in a standard relay rack on a 5¼" high x 19" panel 12" deep. Relay excitation is 24 volts. Resistance ratio and absolute resistance are said to be accurate to 0.001%.—*Julie Research Laboratories,* 566 *West* 168*th St., New York* 32, *N. Y.*

For more information circle **396** on inquiry card.

AUTOMATIC LEAD FORMER

New Lead Former automatically forms coaxial leads of resistors, capacitors, diodes, coils, etc. Components feed to machine down zigzag chute. Parts are clamped in position on leads, close to the body, to prevent injury to delicate parts. As finished

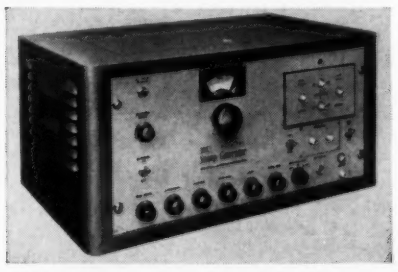


component is ejected the next part is released from chute into clamp. Control of process may be automatic, manual, or by foot pedal. Production capacity is 5000 or more parts per hour.—*Design Tool Corporation,* 80 *Washington St., New York, N. Y.*

For more information circle **397** on inquiry card.

SWEEP GENERATOR

New wide-band Sweep Frequency Generator, designated Model 900, supplies a sweep signal at any frequency from 0.2 mc to approximately 1,000



mc, with sweep widths as high as 300 mc or as low as 0.1 mc. Maker claims RF output is flat within ±0.5 db over "VHF" range (200 kc to 250 mc), and is flat within ±3 db over the maximum sweep width of 300 mc in the "UHF" range (250 mc to 1,000 mc).—*Jerrold Electronics Corp., 23rd and Chestnut Sts., Philadelphia 3, Pa.*

For more information circle **398** on inquiry card.

BAND PASS NETWORK

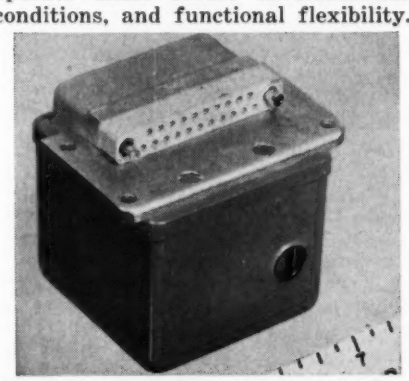
New series 2090 UNIFilter is a pass interstage network featuring exceptional frequency attenuation characteristics with low insertion loss. Available with band widths

ranging from 6 kc to 35 kc at a center frequency of 455 kc, typical adjacent channel rejection is 85 db at plus or minus 40 kc. Other available center frequencies range from 50 kc to 40 mc.—*Ortho Filter Corp., 196 Albion Ave., Paterson 2, N. J.*

For more information circle **399** on inquiry card.

PROGRAM TIMER

New program timer for guided missile or aircraft use is said to feature light weight, small size, ability to operate under severe environmental conditions, and functional flexibility.



Specifications: Size—2½" x 2½" x 2¼" Weight less than 1.1 lbs. Up to 7 circuits may be switched carrying 5 amps inductive at 30 vdc or 2 amps resistance at 115 vac, 400 cps. Accuracy is ±2%, adjustable from 0 to 3 minutes. Operates from electrically wound (28 vdc) spring requiring power only for start.—*Raymond Engineering Laboratory, Inc., Middletown, Conn.*

For more information circle **400** on inquiry card.

MA New Literature

ELECTRONIC COMPONENTS

PRECISION POTENTIOMETERS with linearity as low as ±0.15% are described in new catalog.—Spectrol Electronics Div., Carrier Corp., 1704 South Del Mar Ave., San Gabriel, Calif.

Circle **401** on inquiry card.

MINIATURIZED CAPACITORS with voltage ratings to 25v and capacities from 1 to 50μf are described in new 8-page Catalog 1117B.—Industrial Condenser Corp., 3243 N. California Ave., Chicago 18, Ill.

Circle **402** on inquiry card.

MAGNETIC AMPLIFIERS, transfer networks and vibration testing machines are described and specifications given in new 11-page Product Catalog.—Litton Industries, Maryland Div., 4910 Calvert Rd., College Park, Md.

Circle **403** on inquiry card.

ULTRA SENSITIVE RELAYS and transistorized d-c polar relays are described and illustrated in new Bulletin F-7754-2.—Barber-Colman Co., Rockford, Ill.

Circle **404** on inquiry card.

HYDRAULIC COMPONENTS

MINIATURIZED HYDRAULIC COMPONENTS for missile applications are the subject of 4-page Bulletin A-5216.—Vickers Inc., Aero Hydraulics Div., P.O. Box 302, Detroit 32, Mich.

Circle **405** on inquiry card.

VALVES for Gases and Liquids are described and discussed in new Bulletin 61157.—Robbins Aviation 1735 W. Florence Ave., Los Angeles 47, Calif.

Circle **406** on inquiry card.

MICROWAVE COMPONENTS

WAVEGUIDE COMPONENTS are presented and specifications given for rigid rectangular waveguides, assemblies; also bandwidth data for bends, corners, twists and flanges; and listing of MIL standards are contained in new brochure.—Budd-Stanley Co., Inc., Long Island City, N.Y.

Circle **407** on inquiry card.

MICROWAVE COMPONENTS, hybrid duplexers, flanges and adapters are described and illustrated in new 12-page Catalog C457.—Microwave Development Labs. Inc., 92 Broad St., Babson Park, Wellesley 57, Mass.

Circle **408** on inquiry card.

MICROWAVE AND UHF components and test equipment, including bolometers and thermistors are discussed in new 48-page Catalog.—The Narda Corp., 160 Herricks Rd., Mineola, N. Y.

Circle **409** on inquiry card.

MOTORS—TRANSFORMERS

AC MOTORS, including induction, servo and synchronous units, as well as maker's line of fans and blowers are detailed in new 4-page engineering data release.—Rotating Components Inc., 267 Green St., Brooklyn 22, N. Y.

Circle **410** on inquiry card.

PULSE TRANSFORMERS, miniature and sub-miniature, featuring bifilar and trifilar windings for fast rise time are described in new 2-page release.—Allen B. Du Mont Labs., Inc., Technical Products Div., 760 Bloomfield Ave., Clifton, N. J.

Circle **411** on inquiry card.

VARIABLE TRANSFORMER, miniaturized, for high frequency applications is described in new Bulletin SE-L3573.—The Superior Electric Co., Dept. MPH, 83 Laurel St., Bristol, Conn.

Circle **412** on inquiry card.

VARIACS and variac assemblies, including 20 amp militarized Variac for 350 to 1200 cps are described in new 4-page supplement to Bulletin 0.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **413** on inquiry card.

400 CPS SYNCHROS are described and illustrated in new 4-page brochure; Bu Ord numbers and characteristics are provided.—Muirhead Instruments Inc., 677 Fifth Ave., New York 22, N. Y.

Circle **414** on inquiry card.

TUBES—TRANSISTORS

TUBE AND SEMICONDUCTOR characteristics are described in new 32-page condensed Catalog CC 157 that includes power tube calculation chart.—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle **415** on inquiry card.

SILICON TRANSISTORS are presented with complete specifications and ratings in new Bulletin TE-1353.—Transitron Electronic Corp., Melrose 76, Mass.

Circle **416** on inquiry card.

TUBELESS POWER SUPPLY technical characteristics, including diagrams of maker's "CW-1001" power supply, "CW-1037" transformer-rectifier, and "CW-1033 converter are given in 8-page Bulletin A-1042.—Electrosolids Corp., 7436 Varna Ave., North Hollywood, Calif.

Circle **417** on inquiry card.

NEW LITERATURE

INSTRUMENTS—TEST EQUIPMENT

RECORDING OSCILLOGRAPH for high-temperature high-altitude applications is described in new 6-page Brochure 5-122.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **418** on inquiry card.

POSITION TRANSDUCER for high-precision measurements of angular or linear displacements, and a temperature probe for stable measurement of stagnation air temperature are described in new release.—West Coast Research Corp., 2371½ Westwood Blvd., Los Angeles 64, Calif.
Circle **419** on inquiry card.

FUNCTIONAL TESTER, Model 250F, designed to automatically test continuity, insulation resistance and shorts, is described in new 4-page bulletin.—DIT-MCO, Inc., Electronics Div., 911 Broadway, Kansas City, Missouri.
Circle **420** on inquiry card.

ELECTRONIC GALVANOMETER, a combination d-c null detector, linear deflection indicator, microvoltmeter, micro-microammeter and low-level d-c amplifier is described in new Bulletin 14-3.—KIN TEL (formerly Kay Lab), 5725 Kearny Villa Rd., San Diego, Calif.
Circle **421** on inquiry card.

TIME DELAY AND PULSE generators are described in new short-form 4-page Catalog R715.—Rutherford Electronics Co., 8944 Lindblade St., Culver City, Calif.
Circle **422** on inquiry card.

SIMULATORS—COMPUTERS

SINGLE AXIS flight systems simulator is described in new 4-page brochure.—Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.
Circle **423** on inquiry card.

FLIGHT SIMULATOR that produces roll, pitch and yaw in 3-dimensions with precision hydraulic servos is described in new 8-page bulletin.—Bendix Computer Div., Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.
Circle **424** on inquiry card.

DIODE FUNCTION GENERATOR featuring automatic card programming is featured and illustrated in new 8-page brochure.—Stephen-Douglas Co. Inc., 1650 Twentyfirst St., Santa Monica, Calif.
Circle **425** on inquiry card.

NAVIGATIONAL COMPUTER, ASN-7, that provides present position, direction pilot should fly, ground track of flight, and distance to destination, is described in new 24-page brochure.—Ford Instrument Co., Div. of Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, New York.
Circle **426** on inquiry card.

COMPUDYNE CONTROL SYSTEMS, for aeronautical testing and dynamic systems control are described and illustrated in new 24-page Bulletin G-102.—CDC Control Services, Inc., 582 South Warminster Rd., Hatboro, Pa.
Circle **427** on inquiry card.

3C-PAC universal logical building blocks for hi-speed digital computers are described in new 4-page bulletin.—Computer Control Co., Babson Park, Wellesley, Mass.
Circle **428** on inquiry card.

EQUIPMENT SYSTEMS

S-, C-, X-BAND RADAR beacons, relays, and decoders are subjects of new technical data sheets.—Avion Div., ACF Industries, Inc., 11 Park Place, Paramus, N.J.
Circle **429** on inquiry card.

FIXED FREQUENCY 60kw transmitter for ionosperic scatter communications is described in new 8-page bulletin.—Rixon Electronics Inc., 2414 Reedie Drive, Silver Spring, Md.
Circle **430** on inquiry card.

VHF TRANSMITTER, 20-channel, 118-148 mc, designed to operate with ARC Type R-15, or ARC Type R-19 receivers is described in new brochure ARC T-20.—Aircraft Radio Corp., Boonton, N. J.
Circle **431** on inquiry card.

SYNCHRONOUS RADIO DETECTOR which embodies the double sideband, phase-locking feature of synchronous communications system is discussed in new bulletin.—Light Military Electronic Equipment Dept., General Electric Defense Electronics Div., French Rd., Utica, N. Y.
Circle **432** on inquiry card.

SERVICES—FACILITIES

FACILITIES for electronics, optics and electromechanics as associated with avionics and missiles are described in new 20-page brochure.—Land-Air, Inc., subsidiary of California Eastern Aviation, Inc., 7444 W. Wilson Ave., Chicago 31, Ill.
Circle **433** on inquiry card.

CUSTOM MOLDING service for connectors, electronic embedments, impellers and housings, pipe fittings, disc pistons for meters, coil forms, slip rings, spacers, pump components, stators, etc., are detailed in new catalog sheet.—Epoxy Products Inc., 137 Coit St., Irvington, N. J.
Circle **434** on inquiry card.

FACILITIES for testing electronic components, sub-assemblies, and electronics devices are described in new 8-page brochure.—National Company Inc., 61 Sherman St., Malden, Mass.
Circle **435** on inquiry card.

MAGNESIUM FABRICATIONS for avionics, nucleonics, radar, electronics, guided missiles and business machines, are discussed in new 6-page release.—Falstrom Co., 201 Falstrom Court, Passaic, N. J.
Circle **436** on inquiry card.

TEST CHAMBER specifications are given in new 24-page brochure.—Environmental Equipment Corp., 369 Linden St., Brooklyn 27, N. Y.
Circle **437** on inquiry card.

RACKS—CASES

RACKS for electronic equipment are illustrated and described in new 4-page Bulletin 100-RA.—Craig Systems Inc., Danvers, Mass.
Circle **438** on inquiry card.

PACKAGING HEAVY GOODS in corrugated boxes is discussed in new 26-page booklet.—Hinde and Dauch, Sandusky, Ohio.
Circle **439** on inquiry card.

SHIPPING CONTAINER, reusable, seamless, water tight and conforming to Mil. Specs. is described in new 2-page bulletin.—Follansbee Steel Corp., Follansbee, West Virginia.
Circle **440** on inquiry card.

METAL INSTRUMENT CASES are described in new 62-page catalog featuring 1400 stock sizes.—Zero Manufacturing Co., 1121 Chestnut St., Burbank, Calif.
Circle **441** on inquiry card.

PORTABLE SCOPE DOLLY that holds any laboratory scope is described in new 2-page release.—Metal Fab Co., 12321 Branford St., Pacoima, Calif.
Circle **442** on inquiry card.

MISCELLANEOUS

COOLING LOAD NOMOGRAPH developed for calculation of cooling requirements for military mobile structures and electronic equipment is included in new booklet.—Ellis and Watts Products Inc., Monroe at Spencer, Cincinnati 36, Ohio.
Circle **443** on inquiry card.

FACSIMILE TRANSMISSION of pictures, drawings, printed or handwritten data is discussed in new 4-page pamphlet.—Electronics Div., Stewart-Warner Corp., 1300 N. Kostner Ave., Chicago 51, Ill.
Circle **444** on inquiry card.

ELECTRONIC CABLE as a systems component is discussed and illustrated in new 4-page release.—Pacific Automation Products, Inc., 1000 Air Way, Glendale 1, Calif.
Circle **445** on inquiry card.

CONNECTORS FOR MISSILES are illustrated in new 4-page bulletin.—E. B. Wiggins Oil Tool Co., Inc., 3424 East Olympic Blvd., Los Angeles 23, Calif.
Circle **446** on inquiry card.

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